Capital Project No. WP-169
Long Term Control Plan II

Combined Sewer Overflow Long Term Control Plan For Newtown Creek

Appendix D: Supplemental Documentation
July 2018
Revised October 10, 2018

STATE OF NEW YORK KEITH P MAHONEY LICENSED PROFESSIONAL ENGINEER 074169

Keith Mahoney

Keith Mahoney, P.E.
NY License No. 074169

The City of New York
Department of Environmental Protection
Bureau of Wastewater Treatment

541452

Prepared by: AECOM USA, Inc.

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INTRODUCTION

On June 30, 2017, the New York City Department of Environmental Protection (DEP) submitted the Newtown Creek Long Term Control Plan (LTCP) to the New York State Department of Environmental Conservation (DEC). DEP received DEC's review comments on the LTCP on November 9, 2017. DEP and DEC technical staff discussed technical comments on December 19, 2017. DEP's responses were sent January 8, 2018, however, some of the comments required additional evaluation and technical analysis. DEP provided the requested information in a Technical Memorandum on April 30, 2018. DEC approved the Newtown Creek LTCP on June 27, 2018, with the changes to the LTCP outlined in DEP's January 8, 2018 response letter and April 30, 2018 Technical Memorandum. The DEC's June 27, 2018 approval letter further clarified that with regard to additional floatables control at outfalls BB-009 and NCQ-029, DEP shall submit an approvable floatables monitoring plan for these two outfalls as well as for floatables post-construction monitoring for CSO outfalls BB-026, NCQ-077, NCB-083 and NCB-015, by August 31, 2018. Based on the outcome of the floatables monitoring, DEC will determine if additional floatables control is justified at outfalls BB-009 and NCQ-029.

In discussions held with DEC subsequent to the June 27, 2018 approval letter, it was agreed that the additional information developed in response to DEC's comments on the June 30, 2017 LTCP would be incorporated into the LTCP through this Supplemental Documentation.

The information presented below is organized by LTCP section. All changes are highlighted in yellow. Deleted text is marked by strike-outs, and new text is underlined. DEP's January 8, 2018 response to DEC's November 9, 2017 comment letter on the Newtown Creek LTCP is included as Attachment 1. Attachment 2 provides responsiveness summaries to public comments received prior to and following the June 30, 2017 submittal of the LTCP to DEC.

EXECUTIVE SUMMARY EDITS

The following edits are hereby incorporated into the Executive Summary of the Newtown Creek LTCP:

Section 1 (Page ES-4)

On March 20, 2017, the City submitted extensive comments to EPA on the Draft RI Report. ~~The City concurs with comments from DEC, dated March 16, 2017, and from EPA, dated May 9, 2017, in which each stated that "[b]iological data from reference areas with CSO point source discharges indicate risk from CERCLA [chemicals of potential concern (COPCs)] as evaluated from these data could be significantly decreased to background (reference area) levels even with continuing CSO discharge during storm events." (EPA Comments at ES-3, Specific Comment 9; DEC Comments at 4, Specific Comment 1.g).~~

Section 1 (Page ES-5)

Table ES-2 is deleted, and replaced in its entirety by the following Table ES-2.

Table ES-2. 2008 Baseline CSO Volume and Overflows per Year – Newtown Creek CSOs

Waterbody/WWTP System	CSO	Volume	Annual Overflow Events
		Total Discharge (MG/yr)	Total (No./yr)
Dutch Kills/BBL[1]	BB-004	0.1	1
	BB-009	43.0	34
Newtown Creek/BBL	BB-010	0.5	7
	BB-011	1.6	14
	BB-012	0.1	1
	BB-013	16.2	31
	BB-014	1.8	18
	BB-015	0.7	13
Dutch Kills/BBL	BB-026[3]	120	37
	BB-040	1.1	16
Newtown Creek/BBL	BB-042	1.5	22
	BB-043	9.4	32
English Kills/NCWWTP[2]	NCB-015[3]	321	31
Newtown Creek/NCWWTP	NCB-019	3.0	21
	NCB-021	0.0	0
	NCB-022	7.5	29
	NCB-023	0.5	8
	NCQ-029	18.7	40
Maspeth Creek/NCWWTP	NCQ-077[3]	300	41
Newtown Creek/NCWWTP	NCB-083[3]	314	42
	NCB-002[4]	N/A	N/A
Total		1,161	42 (max)

Notes:

(1) BBL = Bowery Bay Low Level Interceptor, to Bowery Bay WWTP
(2) NCWWTP = Newtown Creek WWTP system
(3) NCB-015 + NCB-083 + NCQ-077 + BB-026 = 91% of Total Annual Volume.
(4) NCB-002 is the Newtown Creek WWTP high relief outfall that discharges to Whale Creek Canal. This flow is treated before discharge.

Section 2 (Page ES-27)

The selection of the preferred alternative is based on multiple considerations including public input, environmental and water quality benefits, and costs. A traditional knee-of-the-curve (KOTC) analysis is presented in Section 8.5 of the LTCP. As described above, based on that analysis, a ~~24~~ 26 MGD expansion to the BAPS was identified as the most cost-effective alternative for reducing the frequency and volume of CSOs from Outfall BB-026 to Dutch Kills.

Section 2 (Page ES-30)

The implementation of the preferred alternative, which would include the storage tunnel for Outfalls NC-015, NC-083 and NC-077, plus the expansion of the BAPS to 26 MGD, has an estimated NPW ranging from $703M to $730M. This estimate reflects $5.0M of annual O&M over the course of 20 years, and an unescalated PBC ranging from $570M to $597M, depending on the final route to be determined in subsequent planning and design stages. Costs escalated to the assumed midpoint of construction would range from $1,275M to $1,335M. Note that these costs do not include costs for land acquisition, design and construction management.

As a supplemental evaluation, the feasibility of providing floatables control via underflow baffles at outfalls BB-009, BB-013, and NCQ-029 was assessed. This evaluation did not affect the cost, performance, or WQS attainment of the preferred alternative described above. The supplemental floatables control evaluation determined that modifications to the regulator structures associated with each of the three outfalls would be required in order to maintain hydraulic neutrality with the underflow baffles in place. At BB-009 and BB-013, raising and lengthening the static weir would be required, while at NCQ-029, lengthening the weir and providing a bending weir would be required. Based on a preliminary siting assessment, the modifications at BB-009 appear to be feasible, but siting limitations would make the regulator modifications needed at BB-013 infeasible. For NCQ-029, more detailed information on existing utilities in the vicinity of the regulator structure is required in order to confirm the feasibility of the required regulator modifications. The NPW of providing underflow baffles at BB-009 and NCQ-029 (if feasible) was estimated at $25.5M. This estimate reflects $36,400 of annual O&M cost over the course of 20 years, and an unescalated PBC of $25.0M.

Section 3 (Page ES-32)

Summary of Recommend Plan

Water quality for bacteria and dissolved oxygen in Newtown Creek is projected to be improved through the implementation of the following: (1) currently planned improvements including those recommended in the 2011 WWFP; (2) planned GI projects: and (3) the implementation of this recommended Newtown Creek LTCP alternative which calls for the design, construction, and operation of an expansion of the BAPS to 26 MGD to provide 75 percent control of the annual CSO volume at Outfall BB-026, and a CSO Storage Tunnel that will be sized to provide 62.5 percent control of Outfalls NC-015, NC-083 and NC-077. The final dimensions and route for the storage tunnel will be further evaluated and finalized during subsequent planning and design stages. A floatables monitoring program will be implemented to assess the need for providing floatables control at outfall BB-009 and potentially at outfall NCQ-029, if feasible. If the monitoring program supports the need for floatables control at those two outfalls, the feasibility of an underflow baffle and bending weir for floatables control at outfall NCQ-029 would need to be confirmed in design. The Dutch Kills aeration system could also be eliminated based on the baseline attainment of the Class SD DO criterion. These identified actions have been balanced with input from the public and awareness of the cost to rate payers.

SECTION 1 EDITS

The following edits are hereby incorporated into Section 1 of the Newtown Creek LTCP:

Section 1.2 (Page 1-4)

On March 20, 2017, the City submitted extensive comments to EPA on the Draft RI Report. ~~The City concurs with comments from DEC, dated March 16, 2017, and from EPA, dated May 9, 2017, in which each stated that “[biological data from reference areas with CSO point source discharges indicate risk from CERCLA [chemicals of potential concern (COPCs)] as evaluated from these data could be significantly decreased to background (reference area) levels even with continuing CSO discharge during storm events.” (EPA Comments at ES-3, Specific Comment 9; DEC Comments at 4, Specific Comment 1.g).~~

SECTION 2 EDITS

The following edits are hereby incorporated into Section 2 of the Newtown Creek LTCP:

Section 2.1.b (Page 2-16)

Figure 2-8 is deleted, and replaced in its entirety by the following Figure 2-8.

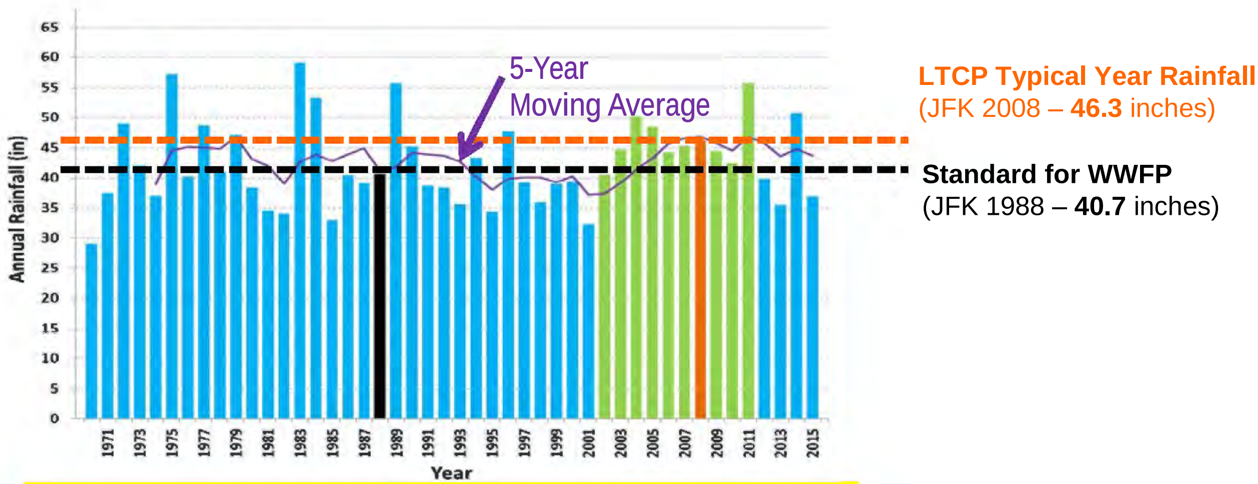

Figure 2-8. Annual Rainfall Data and Selection of the Typical Year

Section 2.1.c (Page 2-17)

Table 2-4 is deleted, and replaced in its entirety by the following Table 2-4.

Table 2-4. Bowery Bay WWTP and Newtown Creek WWTP Sewersheds Tributary to Newtown Creek: Acreage Per Sewer Category

Sewer Area Description	Area (acres)
Combined	**4,642**
Separate MS4	**665**
Direct Drainage	**585**
Other(1)	**923**
Total	**6,815**

Notes: (1) "Other" acreage includes cemeteries and the Amtrak Sunnyside rail yard.

SECTION 6 EDITS

The following edits/underlined text are hereby incorporated into Section 6 of the Newtown Creek LTCP:

Section 6.2 (Page 6-9)

Baseline volumes of CSO to Newtown Creek for each outfall for the 2008 typical year are summarized in Table 6-2, and baseline volumes at East River CSOs associated with the Newtown Creek and Bowery Bay WWTP systems are summarized in Table 6-2a. The total baseline volumes of CSO, stormwater, and direct drainage to Newtown Creek along with the associated fecal coliform, Enterococci, and BOD annual loadings are summarized in Table 6-3. The specific SPDES permitted outfalls associated with these sources are shown in Figure 6-1. Additional tables that summarize annual volumes and loadings can be found in Appendix A.

Table 6-2a. 2008 Baseline CSO Volume and Overflows per Year – East River CSOs Associated with Newtown Creek WWTP and Bowery Bay WWTP Systems

Waterbody/WWTP System	CSO	Volume	Annual Overflow Events
		Total Discharge (MG/yr)	Total (No./yr)
East River/BBL[1]	BB-016	1.8	17
	BB-017	1.7	20
	BB-018	1.1	17
	BB-021	23.4	34
	BB-022	1.0	12
	BB-023	16.4	30
	BB-024	36.4	28
	BB-025	11.0	30
	BB-027	6.1	27
	BB-028	352	44
	BB-029	105	32
	BB-030	27.6	43
	BB-031	3.9	18
	BB-032	1.9	17
	BB-033	6.1	28
	BB-034	202	57
	BB-035	3.9	32
	BB-036	8.9	30
	BB-037	0.6	8
Steinway Creek/BBL	BB-041	84.2	61
East River/BBL	BB-045	0.04	1
	BB-046	7.0	33
	BB-047	2.0	21
Subtotal BBL		**904**	**61 (max)**
East River/NCWWTP[2]	NC-003	0.4	10
	NC-004	15.9	36
	NC-006	92.2	42
	NC-007	7.5	31
	NC-008	21.6	32

Table 6-2a. 2008 Baseline CSO Volume and Overflows per Year – East River CSOs Associated with Newtown Creek WWTP and Bowery Bay WWTP Systems

Waterbody/WWTP System	CSO	Volume	Annual Overflow Events
		Total Discharge (MG/yr)	Total (No./yr)
	NC-010	0.0	0
	NC-012	30.8	15
	NC-013	58.3	28
Wallabout Channel/NCWWTP	NC-014	607	27
East River/NCWWTP	NC-024	0.0	0
	NC-025	0.5	10
	NC-026	0.3	7
	NC-027	13.3	31
	NC-082	0.6	10
Subtotal NCWWTP		**848**	**42 (max)**
Total		**1,752**	**61 (max)**

Notes:

(1) BBL = Bowery Bay Low Level Interceptor, to Bowery Bay WWTP
(2) NCWWTP = Newtown Creek WWTP system

SECTION 8 EDITS

Given the number of edits to Section 8, the entire Section 8 is presented below. All changes are highlighted in yellow, with new text underlined, and deleted text shown with strike-out.

8.0 EVALUATION OF ALTERNATIVES

This section describes the development and evaluation of CSO control measures and watershed-wide alternatives. A CSO control measure is defined as a technology (e.g., treatment or storage), practice (e.g., NMC or BMP), or other method (e.g., source control or GI) of abating CSO discharges or the effects of such discharges on the environment. Alternatives evaluated are comprised of a single CSO control measure or a group of control measures that will collectively address the water quality objectives for Newtown Creek.

This section contains the following information:

- Process for developing and evaluating CSO control alternatives that reduce CSO discharges and improves water quality (Section 8.1).
- CSO control alternatives and their evaluation (Section 8.2).
- CSO reductions and water quality benefits achieved by the higher-ranked alternatives, as well as their estimated costs (Sections 8.3 and 8.4).
- Cost-performance and water quality attainment assessment for the higher-ranked alternatives for the selection process of the preferred alternative (Section 8.5).

As presented in Section 6.2, Table 6-4, three sets of WQS, including fecal coliform and *Enterococci* bacteria WQ criteria and DO criteria, were used to evaluate CSO control alternatives and their corresponding levels of attainment. These evaluations include both existing and possible future WQ criteria.

It should be noted that while this LTCP focuses on attaining WQS in accordance with the CWA and New York State Environmental Conservation Law, EPA is also evaluating the presence of hazardous substances in Newtown Creek in accordance with CERCLA. A draft Remedial Investigation Report was submitted to EPA on November 15, 2016 by the non-City PRPs and is under EPA review. EPA is currently overseeing the performance of a Feasibility Study, also by the non-City PRPs, to evaluate potential remedies for Newtown Creek based on data collected during the Remedial Investigation, as well as on additional sampling and studies. EPA expects to issue a ROD for Newtown Creek, which will set forth EPA's selected remedy for Newtown Creek, in 2020, and it is possible that the ROD may include a CSO mitigation component.

8.1 Considerations for LTCP Alternatives under the Federal CSO Policy

This LTCP addresses the water quality objectives of the CWA and the New York State Environmental Conservation Law. This LTCP also builds upon the conclusions presented in DEP's June 2011 Newtown Creek WWFP. As required by the 2012 CSO Order, when the proposed alternative set forth in the LTCP will not achieve Existing WQ Criteria or the Section 101(a)(2) goals, a Use Attainability Analysis (UAA) must be prepared. A UAA is the mechanism to examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State. If deemed necessary, the UAA would assess compliance with the next higher classification that the State would consider in adjusting WQS and developing waterbody-specific criteria. The remainder of Section 8.1 discusses the development and evaluation of CSO control measures and watershed-wide alternatives to comply with the CWA in general, and with the CSO Control Policy in particular. This section describes the evaluation factors considered for each alternative and a description of the process for evaluating the alternatives.

8.1.a Performance

A summary of the IW model output data for volume and frequency of discharge of the CSO outfalls to Newtown Creek and its tributaries is provided in Table 8-1. The locations of these outfalls are shown in Figure 8-1.

Table 8-1. CSO Discharges Tributary to Newtown Creek (2008 Typical Year)

Combined Sewer Outfalls	Receiving Waters	Discharge Volume (MGY)	No. of Discharges	Percentage of Total CSO Discharge to Newtown Creek
BB-026	Dutch Kills	120	37	10.3%
NC-077	Maspeth Creek	300	41	25.8%
NC-083	East Branch	314	42	27.0%
NC-015	English Kills	321	31	27.7%
Subtotal - Four Largest Outfalls	**Newtown Creek and Tributaries**	**1,055**	**42 (max.)**	**90.9%**
BB-004	Dutch Kills	0	1	
BB-009	Dutch Kills	43	34	3.7%
BB-040	Dutch Kills	1	16	<1.0%
BB-010	Newtown Creek	1	7	<1.0%
BB-011	Newtown Creek	2	14	<1.0%
BB-012	Newtown Creek	0	1	<1.0%
BB-013	Newtown Creek	16	31	1.4%
BB-014	Newtown Creek	2	18	<1.0%
BB-015	Newtown Creek	1	13	<1.0%
BB-042	Newtown Creek	2	22	<1.0%
BB-043	Newtown Creek	9	32	<1.0%
BB-049	Newtown Creek	0	0	0.0%
NCB-019	Newtown Creek	3	21	<1.0%
NCB-021	Newtown Creek	0	0	0.0%
NCB-022	Newtown Creek	7	29	<1.0%
NCB-023	Newtown Creek	0	8	<1.0%
NCQ-029	Newtown Creek	19	40	1.6%
Subtotal – Other Outfalls	**Newtown Creek and Dutch Kills**	**106**	**40 (max.)**	**9.1%**
Total CSO	**Newtown Creek and Tributaries**	**1,161**	**42 (max.)**	**100%**

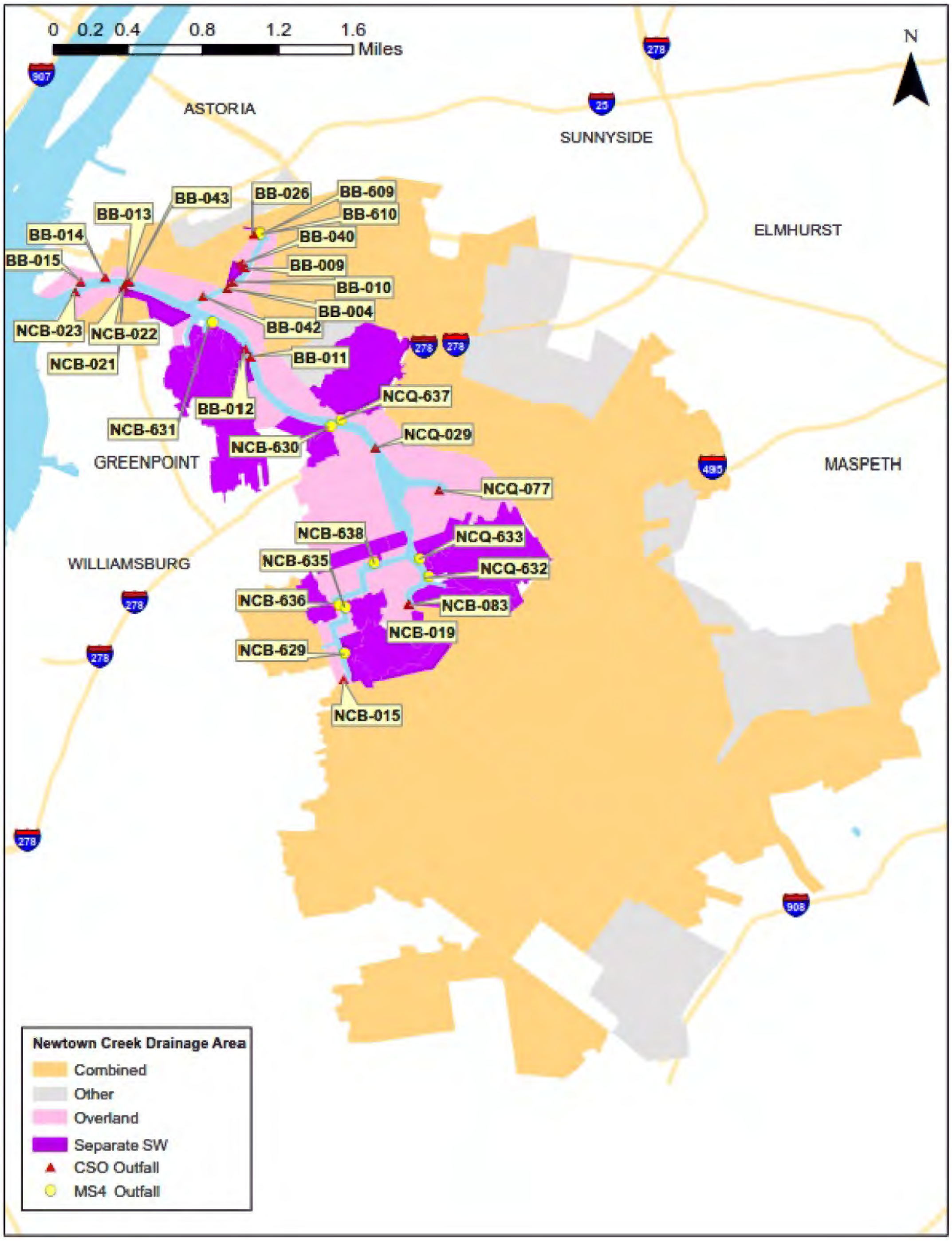

Figure 8-1. CSO Discharges to Newtown Creek

As indicated in Table 8-1, four CSO outfalls - BB-026, NCQ-077, NCB-083 and NCB-015 - generate 91 percent of the total annual CSO discharge volume. None of the other outfalls contributes more than four percent of the total, and most contribute less than one percent of the total. The four outfalls that generate the largest volumes are located at the head ends of four Newtown Creek tributaries: Dutch Kills, Maspeth Creek, East Branch and English Kills, respectively. Because of their headwater locations, the water quality impacts of the loadings from the four largest outfalls are generally measurable throughout the Creek.

To determine the influence of CSO control on the attainment of existing and future WQ criteria, a Performance Gap Analysis was performed. The results of the analysis are summarized in Section 6.3. The evaluations concluded that a performance gap exists because both the Primary Contact WQ Criteria for fecal coliform bacteria and the Class SD DO criterion will not be attained under baseline conditions. As a result, the evaluation of performance for the Newtown Creek alternatives related to bacteria focused on improving the attainment of Primary Contact Bacteria WQ criteria and the designated Class SD DO criterion (>3.0 mg/L). The alternatives evaluations also considered the level of control necessary to achieve the DEC goal for a time to recovery of less than 24 hours after a wet-weather event. Additionally, improvements to the attainment of Potential Future WQ Criteria (RWQC) and the Class SC DO criterion that would be realized by the selected CSO mitigation alternatives have been evaluated and reported.

The analyses in Section 6 showed that under baseline conditions, annual attainment with Existing WQ Criteria for bacteria ranged from 42 to 83 percent, with lower attainment projected towards the head end. While 100 percent CSO control would improve overall annual attainment with Existing WQ Criteria for bacteria, modeling still projected non-attainment in English Kills and East Branch, with an annual attainment of 83 percent. Under baseline conditions during the recreational season (May 1st through October 31st), attainment with Existing WQ Criteria for bacteria ranged from 67 to 100 percent, with lower attainment projected towards the head end. With 100 percent CSO control, projected recreational season (May 1st through October 31st) attainment with Existing WQ Criteria for bacteria was projected to be 100 percent. Overall, the dissolved oxygen had a projected annual attainment with the Existing Class SD WQ Criterion for DO between 90 and 100 percent under baseline conditions that includes seasonal aeration in English Kills and East Branch. Dutch Kills without aeration was projecting an annual attainment with the Existing WQ Criterion for DO between 98 and 99.9 percent.

The primary goals for the development and evaluation of control alternatives are the ability to achieve bacteria load reduction and to attain applicable water quality criteria. The control of floatables is also an important goal and is a consideration for all alternatives. The evaluation of control alternatives typically follows a two-step process. First, based upon IW watershed model runs for the typical year rainfall (2008), the level of CSO control of each alternative is established, including the reduction of CSO volume, fecal coliform and *Enterococci* loading. The second step uses the estimated levels of CSO control to project levels of attainment in the receiving waters. This latter step uses the Newtown Creek Receiving Water Quality Model (NCRWQM). LTCPs are typically developed with alternatives that span a range of CSO volumetric (and loadings) reductions. Accordingly, this LTCP includes alternatives that consider a wide range of reductions in CSO loadings - up to 100 percent CSO control - including investments in green and grey infrastructure. Intermediate levels of CSO volume control, approximately 25, 50 and 75 percent, are typically also evaluated. Table 8-2 provides a summary of the required storage volume and associated peak flow rates that would have to be diverted from the outfalls for each of these levels of CSO control for the four largest CSO outfalls.

Table 8-2. Summary of Storage and Peak Flow Rates Required for Each Level of CSO Control for the Four Largest Outfalls

Required Capacity	25% CSO Control	50% CSO Control	75% CSO Control	100% CSO Control
Storage Capacity (MG)	11	30	59	138
Diverted Peak Flow (MGD)[1]	67	165	343	1,833

Note:
(1) Peak flow that would have to be conveyed to storage or treatment to provide the targeted level of CSO control.

Figures 8-2 and 8-3 show plots of the required volumes and flow rates for these four large outfalls.

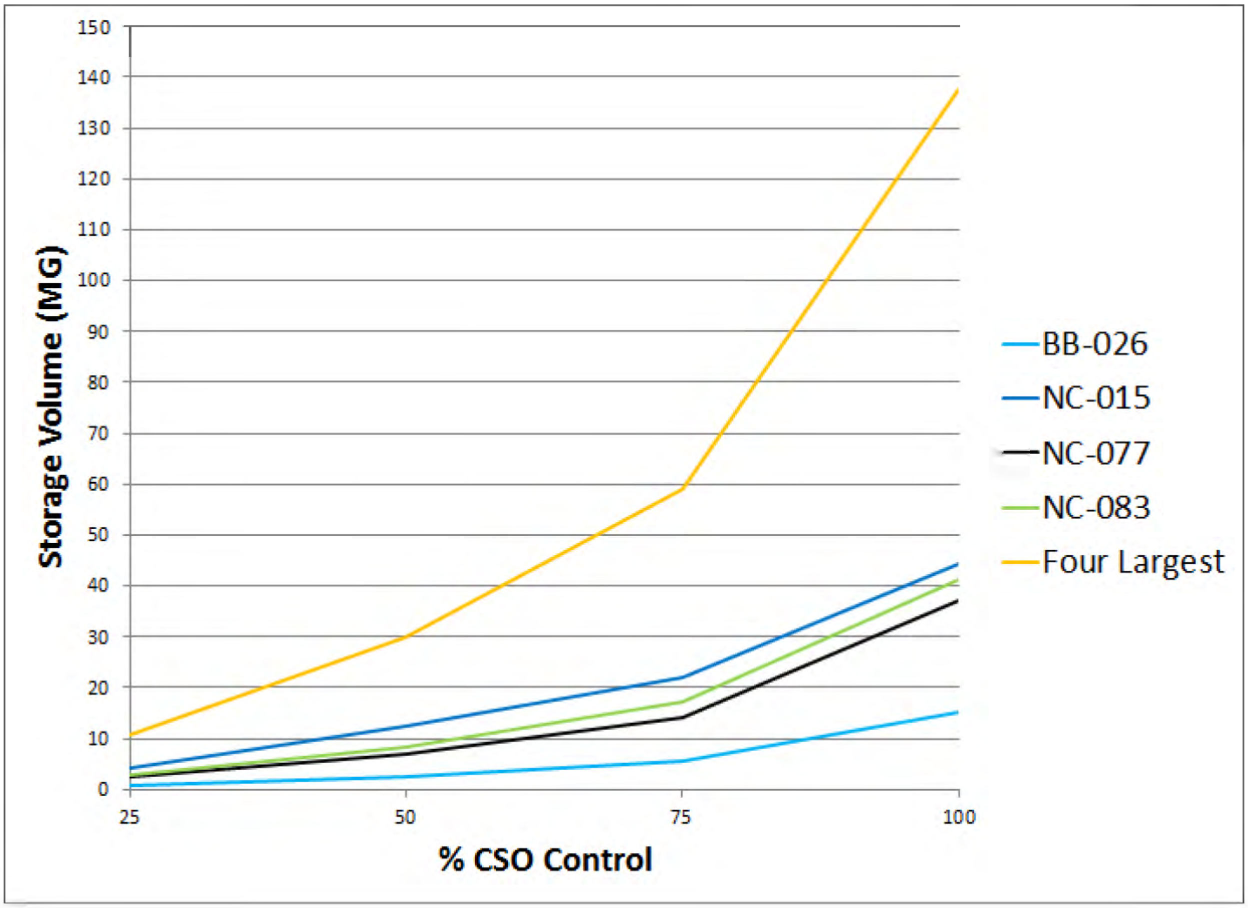

Figure 8-2. Required Storage Volume for Various Levels of CSO Control for Four Largest Outfalls

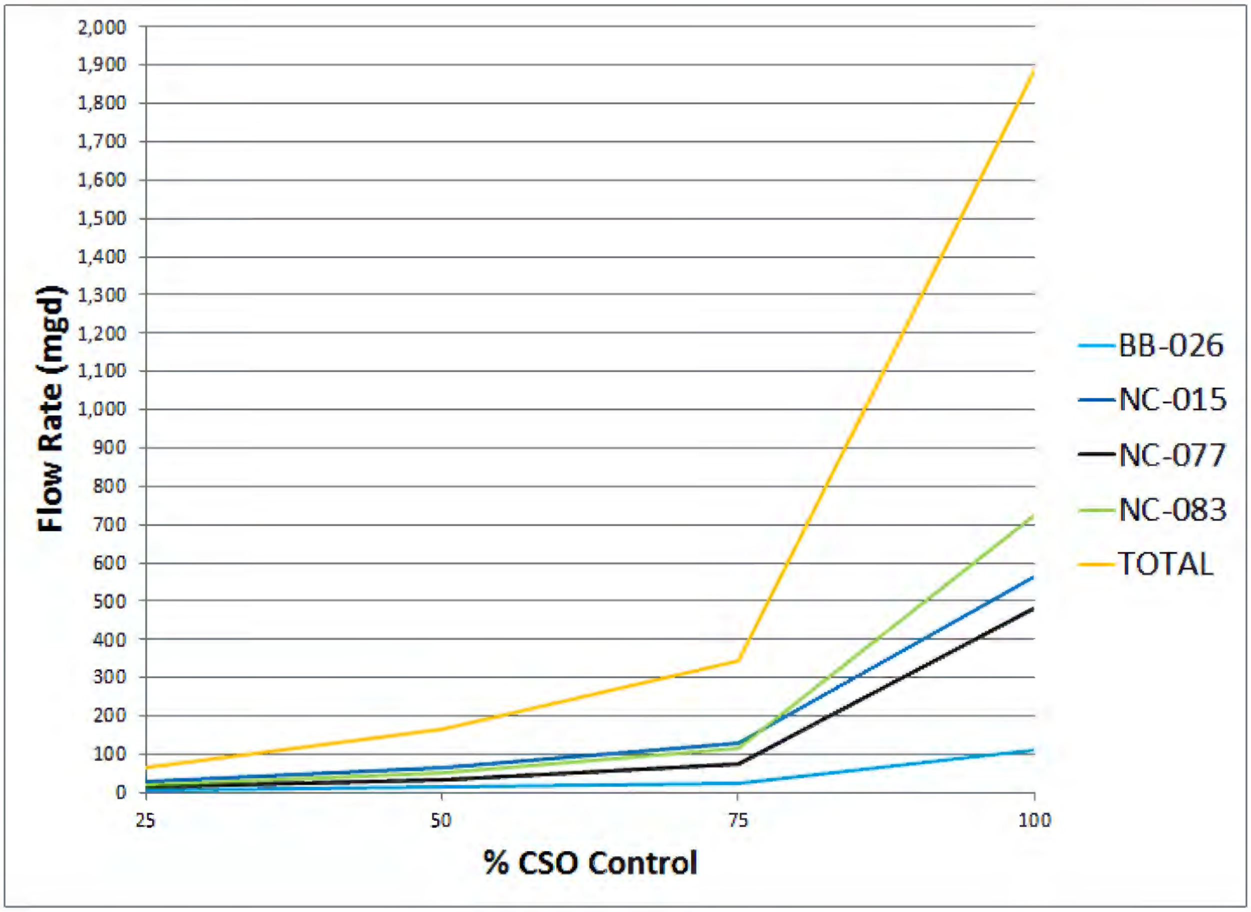

Figure 8-3. Required Diverted Peak Flow for Various Levels of CSO Control for the Four Largest Outfalls

8.1.b Impact on Sensitive Areas

In developing LTCP alternatives, special effort is made to minimize the impact of construction, to protect existing sensitive areas, and to enhance water quality in sensitive areas. As described in Section 2.0, no sensitive areas were identified within the Newtown Creek watershed. As such, only construction impacts were considered, as appropriate.

8.1.c Cost

Cost estimates for the alternatives were computed using a costing tool based on parametric costing data. This approach provides an AACE Class 5 estimate (accuracy range of minus 20 to 50 percent to plus 30 to 100 percent), which is typical and appropriate for this type of planning evaluation. For the purpose of this LTCP, all costs are in February 2017 dollars.

For the LTCP alternatives, Probable Bid Cost (PBC) was used as the estimate of the construction cost. Annual operation and maintenance costs were then used to calculate the total or net present worth (NPW) over the projected useful life of the project. In general, a lifecycle of 20 years and an interest rate of 3.0 percent were assumed resulting in a Present Worth Factor of 14.877. However, for tunnel alternatives, which provide longer service, a 100-year lifecycle was considered and a corresponding Present Worth Factor of 31.599 was used.

To quantify costs and benefits, alternatives were compared based on reductions of both CSO discharge volume and bacteria loading against the total cost of the alternative. These costs were then used to plot the performance and attainment curves. A pronounced inflection point appearing in the resulting graphs, the so-called knee-of-the-curve point, suggests a potential cost-effective alternative for further consideration. In theory, this would reflect the alternative that achieves the greatest appreciable water quality improvements per unit of cost. However, cost/performance or cost/attainment curves do not always identify a distinct "knee," and if an alternative does fall on a distinct "knee," it may not necessarily be the preferred alternative. The final, or preferred, alternative must be capable of improving water quality in a fiscally responsible and affordable manner to ensure that resources are properly allocated across the overall citywide LTCP program. These monetary considerations also must be balanced with non-monetary factors, such as construction impacts, environmental benefits, technical feasibility, and operability, which are discussed below.

8.1.d Technical Feasibility

Several factors were considered when evaluating technical feasibility, including:

- Effectiveness for controlling CSO
- Reliability
- Implementability

The effectiveness of CSO control measures was assessed based on their ability to reduce CSO frequency, volume and load. Reliability is an important operational consideration, and can have an impact on overall effectiveness of a control measure. Therefore, reliability and proven history were used to assess the technical feasibility of a CSO control measure.

Several site-specific factors were considered to evaluate an alternative's implementability, including available space, neighborhood assimilation, impact on parks and green space, and overall practicability of installing - and later maintaining - CSO controls. In addition, the method of construction was factored into the final selection. Some technologies require specialized construction methods that typically incur additional impacts as well as costs.

8.1.e Cost-Effective Expansion

All alternatives evaluated were sized to handle the CSO volumes based on the 2008 typical year rainfall and 2040 design year dry-weather flows, with the understanding that the predicted and actual flows may differ. To help mitigate the difference between predicted and actual flows, adaptive management was considered for those CSO technologies that can be expanded in the future to capture or treat additional CSO flows or volumes, should it be needed. In some cases, this may have affected where the facility would be constructed, or gave preference to a facility that could be expanded at a later date with minimal cost and disruption of operation.

Breaking construction into segments allows adjustment of the design of future phases based on the performance of already-constructed phases. Lessons learned during operation of current facilities can be incorporated into the design of future facilities. However, phased construction also exposes the local community to a longer construction period. Where applicable, for those alternatives that can be expanded, the LTCP takes into account the ease of expansion, what additional infrastructure may be required, and if additional land acquisition would be needed.

As regulatory requirements change, other water quality improvements may be required. The ability of a CSO control technology to be retrofitted to address additional pollutant parameters or more stringent discharge limits strengthens the case for application of that technology.

8.1.g Long Term Phased Implementation

Recommended LTCP implementation steps associated with the preferred alternative are typically structured in a way that makes them adaptable to change by expansion and modification resulting from possible new regulatory and/or local drivers. If applicable, the project(s) would be implemented over a multi-year schedule. Because of this, permitting and approval requirements must be identified prior to selection of the alternative. With the exception of GI, which is assumed to occur on both private and public property, most of the CSO grey technologies target municipally owned property and right-of-way-acquisitions. DEP will work closely with other NYC agencies and, as necessary, with NYS, to ensure proper coordination with other government entities.

8.1.h Other Environmental Considerations

DEP has considered minimizing impacts on the environment and surrounding neighborhood during construction. These impacts could potentially include traffic, site access issues, park and wetland disruption, noise pollution, air quality, and odor emissions. To minimize environmental impacts, they will be identified with the selection of the preferred plan and communicated to the public. The specific details on mitigation of the identified concerns and/or impacts, such as erosion control measures and the rerouting of traffic, are addressed later as part of a pre-construction environmental assessment.

8.1.i Community Acceptance

As described in Section 7, DEP is committed to involving the public, regulators, and other stakeholders throughout the planning process. Community acceptance of the recommended plan is essential to its success. As such, DEP uses the LTCP public participation process to present the scope of the LTCP, background, newly collected data, WQS and the development and evaluation of alternatives to the public and to solicit its support and feedback. The Newtown Creek LTCP is intended to improve water quality, and public health and safety are its priorities. The goal of raising awareness of and access to waterbodies was also considered throughout the alternative analysis. Several CSO control measures, such as GI, have been shown to enhance communities while increasing local property values. As such, the benefits of GI were considered in the formation of the baseline and the final recommended plan.

8.1.j Methodology for Ranking Alternatives

The multi-step evaluation process DEP used to develop the Newtown Creek LTCP accomplished the following:

1. Evaluated benchmarking scenarios, including baseline and 100 percent CSO control, to establish a range of controls within the Newtown Creek watershed for consideration. The results of this step were described in Section 6.
2. Used baseline conditions to prioritize the CSO outfalls for possible controls.

3. Developed a list of promising control measures for further evaluation based in part on the prioritized CSO list.
4. Established levels of intermediate CSO control that provide a range between baseline and 100 percent CSO control for the receiving water quality simulations that were conducted.
5. Held a Challenge Team Workshop on March 31, 2016, to brainstorm ideas ahead of the formal alternatives development process.
6. Toured the Narragansett Bay Commission (Providence, RI) CSO tunnel (as part of the Flushing Bay LTCP development) on October 19, 2016, to solicit feedback and lessons learned.
7. Conducted an initial "brainstorming" meeting with DEP staff on January 12, 2017, to review the most promising control measures and to solicit additional options to explore.
8. Held a meeting with DEP Bureau Executives on January 30, 2017, to develop presentation materials for joint DEC/EPA meeting.
9. Held a meeting with DEC and EPA staff on February 16, 2017, to present water quality sampling results, baseline modeling, WQS attainment and preliminary CSO control alternatives, and to review the progress to-date on the alternatives development.
10. Held a second "brainstorming" meeting with DEP staff on March 22, 2017, to further review additional details on the most promising control measures and to solicit additional options to further explore.
11. Conducted meetings with DEP staff on March 30 and April 4, 2017, to prepare for Inter-Bureau Alternatives Workshop.
12. Conducted a follow-up workshop with operations staff on April 10 2017, to review the progress to-date on the alternatives development and to solicit input and concerns on operability, and to select a shortlist of retained alternatives.
13. Toured the Monroe County (Rochester, NY) CSO tunnel on May 10, 2017, to solicit feedback and lessons learned.
14. Presented findings of retained alternatives to DEC on June 13, 2017.

The focal points of this process were the meetings and workshops listed above. Prior to the first meeting, the control measures that were evaluated in the 2011 WWFP were revisited from the perspective of the LTCP goal statement and in light of the implemented WWFP controls. Additional control measures were also identified and assessed. The resultant control measures were introduced at the first meeting. Based on discussions at that meeting, further additional control measures were identified. A preliminary evaluation of these control measures was then conducted including an initial estimation of costs and water quality CWA impacts. During the second meeting, promising alternatives were reviewed in more detail. The LTCP workshops, attended by a broader array of DEP operational and engineering staff, included updated alternative assessments.

Categories of control measures considered included, Source Control, System Optimization, CSO Relocation, Water Quality/Ecological Enhancement, Treatment and Storage. Specific control measures considered under each category were as follows:

Source Control

- Additional and Existing Green Infrastructure
- Sewer Separation

System Optimization

- Fixed Weirs
- Parallel Interceptor/Sewer
- Inflatable Dams, Bending Weirs or Control Gates
- Pumping Station Expansion/Optimization

CSO Relocation

- Gravity Flow Tipping to Other Watersheds
- Pumping Station Modification
- Flow Tipping with Conduit/Tunnel and pumping

Water Quality/Ecological Enhancement

- Floatables Control
- Environmental Restoration
- In-Stream Aeration
- Flushing Tunnel

Treatment

- Outfall Disinfection
- Retention Treatment Basin
- High Rate Clarification
- WWTP Expansion

Storage

- In-System/Outfall
- Shaft
- Tank
- Tunnel

Figure 8-4 presents these control measures according to their relative cost and level of complexity. The control measures in the upper left corner are generally the least costly and least complex to construct and/or operate, while those towards the lower right are the most costly and most complex to construct and/or operate. The level of loading removal performance of each measure typically corresponds with the level of cost and complexity.

Following the initial screening meeting, control measures were advanced to a second level of evaluation with the exception of the following (either marked with an "X" or highlighted as an ongoing project in Figure 8-4):

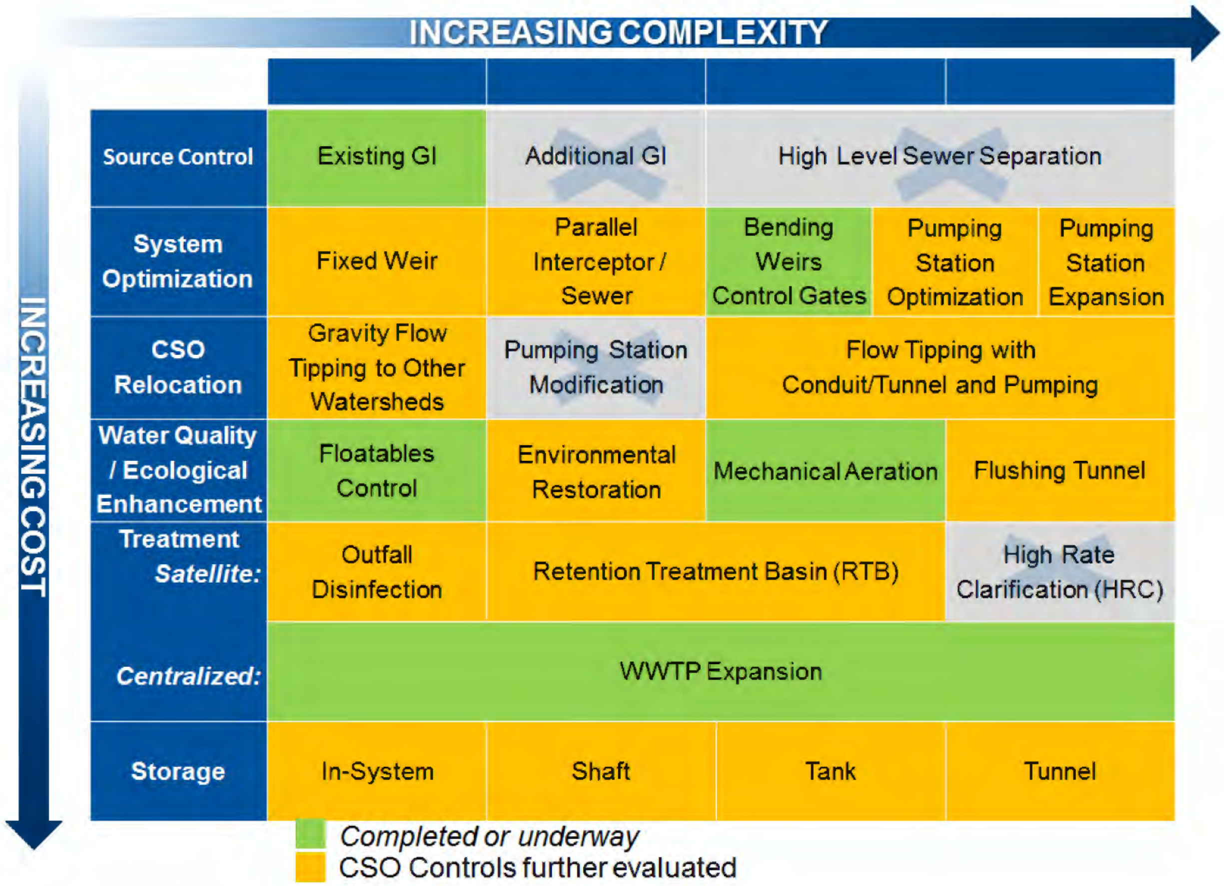

Figure 8-4. Matrix of CSO Control Measures for Newtown Creek

- *Additional and Existing Green Infrastructure (GI):* Newtown Creek is a priority target area for DEP's Green Infrastructure Program. DEP has installed or plans to install over 1,300 GI assets consisting of right-of-way (ROW) practices, public property retrofits, and GI implementation on private properties. Figure 8-5 illustrates the location of the built or planned GI projects. While GI will be encouraged in areas proposed for redevelopment, site characteristics in publicly owned rights-of-way throughout the sewershed limit the ability to implement additional GI. As noted in Section 5, the GI in the Newtown Creek watershed is projected to result in a CSO volume reduction of approximately 83 MGY, based on the 2008 baseline rainfall condition. Because the application of additional GI would rely on commitments from private property owners, it is not feasible to identify and commit definitively to such private GI projects within the timeframe for development of this LTCP. As a result, application of additional GI will not be evaluated as part of this LTCP. Nevertheless, DEP will continue to develop programs to incentivize the application of GI by private property owners for the purposes of managing stormwater runoff.

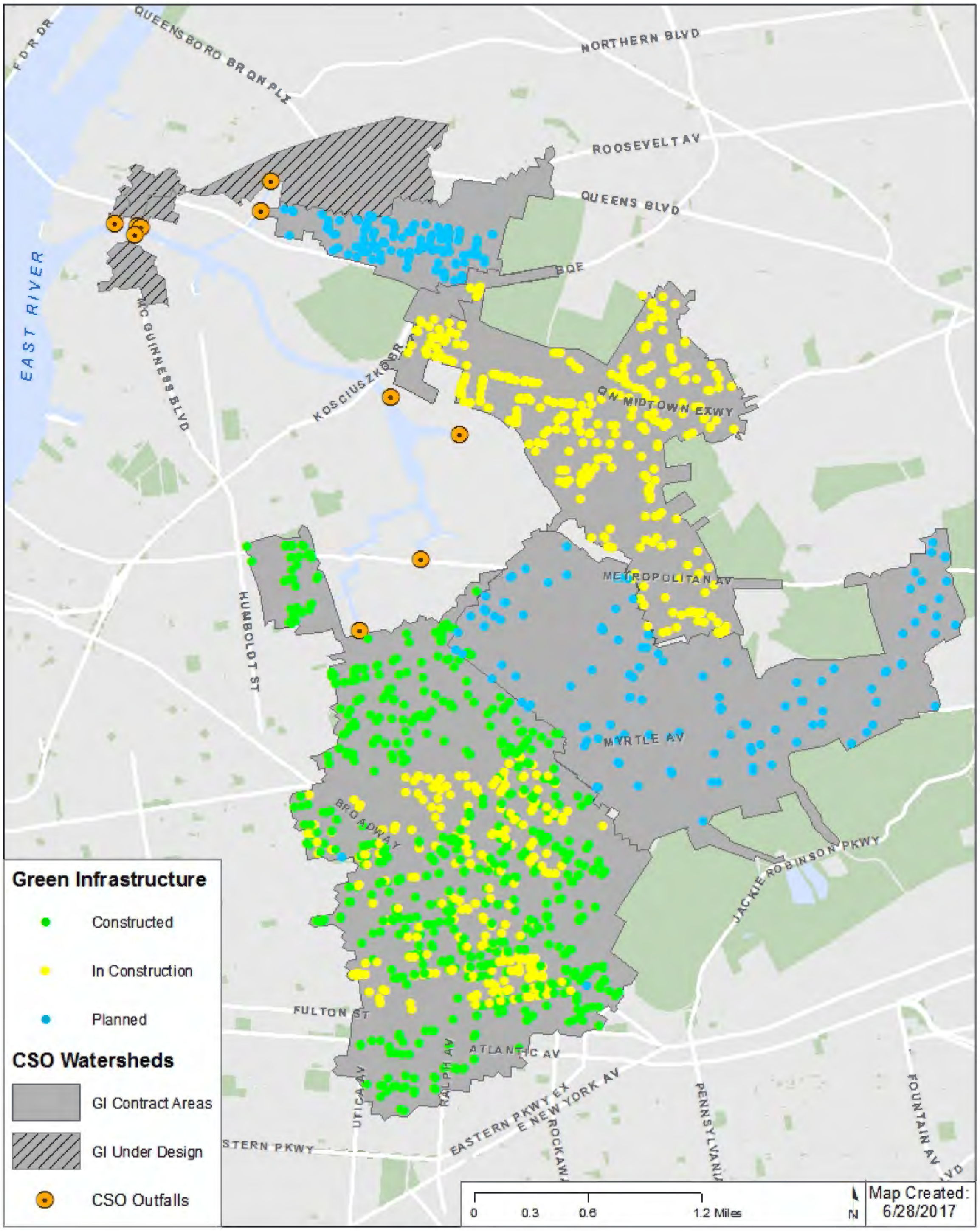

Figure 8-5. Built and Planned Green Infrastructure Projects

- *Sewer Separation:* The drainage areas tributary to the four largest CSO outfalls - BB-026, NC-077, NC-083 and NC-015 - are expansive and generate large volumes of annual discharge. The cost and disruption to the neighborhoods to separate sewers would be significant while only providing limited water quality benefits due to the resultant stormwater discharges. DEP has typically employed so-called high level storm sewer (HLSS) – i.e., the removal of public rights-of-way runoff from streets and sidewalks – only where localized flooding problems have occurred, rather than as a CSO control measure. Because flooding has not been identified as an issue in this watershed, HLSS was not considered for Newtown Creek.

  As a partial separation alternative, DEP considered redirecting the stormwater runoff generated on the large area of cemeteries along the northeastern edge of the Newtown Creek watershed. IW modeling indicated that about a 12 percent basin-wide CSO volume reduction could possibly be achieved by rerouting that stormwater directly to Newtown Creek. However, after further evaluation, it was determined that, as with HLSS, extensive new conveyance piping would be needed to redirect the cemetery-generated runoff to the Creek. As a result, both HLSS and this focused cemetery-generated stormwater redirection were eliminated from further consideration.

- *Inflatable Dams, Bending Weirs, Control Gates:* Mechanical methods of regulating CSO were evaluated under the 2011 WWFP. As described above, of these measures, bending weirs were deemed the most applicable control for the four largest outfalls due to the concern of adverse upstream hydraulic grade line impacts. Because the bending weirs already are being implemented, and nothing has changed regarding the potential hydraulic grade line impacts of the other technologies, these control measures were eliminated from further consideration, except as noted below under Floatables Control.

- *Pumping Station Modification:* The majority of the combined sewage in the Newtown Creek watershed is pumped to the Newtown Creek WWTP through the Brooklyn/Queens Pumping Station (BQPS). Per the Newtown Creek WWTP WWOP, the BQPS pumps a maximum of 400 MGD to the plant. The pumping station and the system of gates that control the inflow to the wet well were upgraded recently. The Newtown Creek WWTP also receives flow from the Manhattan portion of the sewershed via the Manhattan Pumping Station. Theoretically, flow from the Manhattan Pumping Station could be throttled during wet-weather, and the capacity of the BQPS expanded to keep the total peak flow to Newtown Creek WWTP at its peak design capacity of 700 MGD. However, hydraulic evaluations and the IW model have indicated that increasing the capacity of the BQPS would not significantly reduce CSO volumes to Newtown Creek, due to conveyance limitations along the Morgan Avenue interceptor (i.e., the additional peak flow could not get to the pumping station). As a result, further modification of the BQPS was not considered. The expansion of the Borden Avenue Pump Station was identified for further evaluation as described below. No other sanitary pump stations within the Newtown Creek drainage area discharge to the Bowery Bay WWTP system.

- *Floatables Control*: Underflow baffles ~~are being installed currently~~ were recently constructed at the four largest outfalls (BB-026, NC-015, NC-077 and NC-083) as part of the Bending Weirs/Floatables Control Project recommended in the 2011 WWFP~~Regulator Improvement Project~~, and a floatables control boom is located at the mouth of Maspeth Creek and near the head-end of English Kills and East Branch . Further, the control measures described below that include storage or treatment would inherently also capture floatables. As such, additional measures that specifically target floatables control were not initially considered. However, in response to comments from the DEC, providing underflow baffles at regulators associated with the next three largest outfalls to Newtown Creek in terms of annual overflow volume (BB-009, BB-013, and NCQ-029) was evaluated. The findings of this evaluation are presented in Section 8.2.a.1 below.

- *Environmental Dredging*: DEP conducted maintenance dredging of portions of Newtown Creek in April/May 2014. The dredging area encompassed the lower portion of the Creek, approximately between the mouth and Whale Creek, to improve navigability up to the new sludge loading dock near the Newtown Creek WWTP. Because EPA is currently evaluating dredging alternatives under the Superfund process, DEP did not consider that measure under this LTCP.
- *In-stream Aeration*: In-stream aeration has already been installed in English Kills and in East Branch. WQ modeling evaluations indicated that without those aeration systems, the Class SD DO criterion would not be achieved in the upstream reaches of Newtown Creek even with 75 percent CSO control. With 100 percent CSO control, the criterion still would not be met at Station NC-014 in English Kills. Therefore, it is recommended that the East Branch and English Kills aeration systems remain in operation. However, the WQ assessments indicated that the Class SD DO criterion is currently being met in Dutch Kills and the main trunk of Newtown Creek under baseline conditions. Therefore, the previously-proposed Dutch Kills aeration system is recommended to be eliminated.
- *High Rate Clarification*: High rate clarification is typically employed for CSO discharges when high levels of suspended solids and BOD reductions are targeted for control in addition to bacteria and floatables. Because high rates of removal of these parameters were not identified as concerns for the Newtown Creek watershed, this control measure was eliminated from further consideration.
- *WWTP Expansion*: As noted above, the benefit of expanding the WWTP capacity would be limited by the capacity of the collection system to convey additional wet-weather flow to the plant. In addition, because space constraints limit the ability to expand existing plant processes, storage or remote treatment was considered in lieu of WWTP expansion.
- *Storage Shafts*: Shaft storage involves constructing a deep circular shaft to provide storage, with pump-out facilities to dewater the shaft after the storm event. Shaft storage construction techniques would be similar to those used to construct deep tunnel drop or access shafts. The benefit of shaft storage is that it allows for relatively large storage volumes with relatively small facility footprints. Disadvantages of shaft storage include limits to the depth of shafts, complex dewatering pumping operations, and difficult maintenance. Another disadvantage is that very few operating shaft storage systems exist from which to gain insight on operational issues and experience. Finally, the largest shaft currently in operation is 7.5 MG. Using that size as a maximum, multiple units would be required at the largest Newtown Creek outfalls. Because the range of levels of CSO control could be provided by more conventional tunnels or, in some cases, tanks, storage shafts do not offer advantages sufficient to outweigh their disadvantages. For these reasons, shaft storage was eliminated from further evaluation.

The evaluation of the retained control measures is described in Section 8.2.

8.2 Matrix of Potential CSO Reduction Alternatives to Close Performance Gap from Baseline

Each control measure was initially evaluated on three of the key considerations described in Section 8.1: (1) benefits, as expressed by level of CSO control and attainment; (2) costs; and (3) challenges, such as siting and operations. Using this methodology, the retained control measures listed in Section 8.1 were evaluated on a cost-performance basis and used to develop the basin-wide alternatives.

Following the LTCP outline, these control measures are described under the following categories: Other Future Grey Infrastructure, Other Future Green Infrastructure and subsets thereof.

8.2.a Other Future Grey Infrastructure

For the purpose of this LTCP, “Other Future Grey Infrastructure” refers to potential grey infrastructure beyond existing control measures implemented based on previous planning documents. “Grey infrastructure” refers to systems used to control, reduce, or eliminate discharges from CSOs. These are the technologies that DEP and other wastewater utilities typically have used in their CSO planning and implementation programs. They include retention tanks, tunnels and treatment facilities, including satellite facilities, and other similar capital-intensive facilities.

Grey infrastructure projects implemented under previous CSO control programs and facility plans, such as the 2011 WWFP, are described in Section 4. To summarize, those projects include:

1. Upgrade of Brooklyn/Queens Pumping Station to 400 MGD capacity.
2. The Regulator Improvement Project to install underflow baffles and bending weirs at regulators associated with the four largest CSO outfalls, specifically BBL-4, NCQ-01, NCB-01 and the NC-St. Nicholas Weir regulator. Figure 8-6 shows the longitudinal profile at one of the regulators, NCQ-01.
3. In-stream aeration at English Kills and East Branch (Figure 8-7).

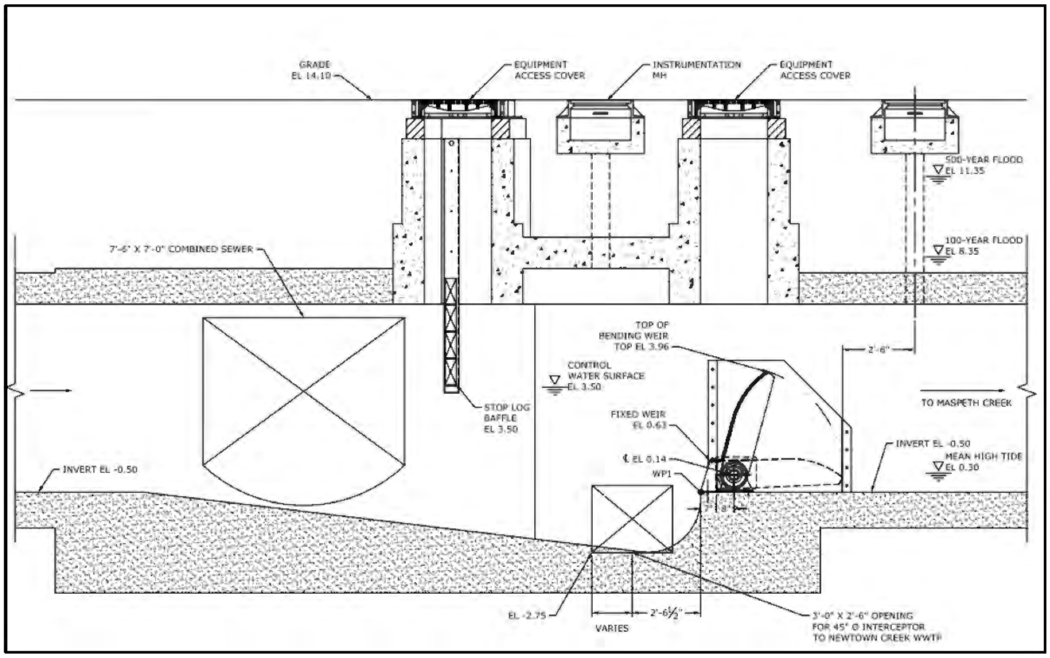

Figure 8-6. Bending Weir and Underflow Baffle at Regulator NCQ-01

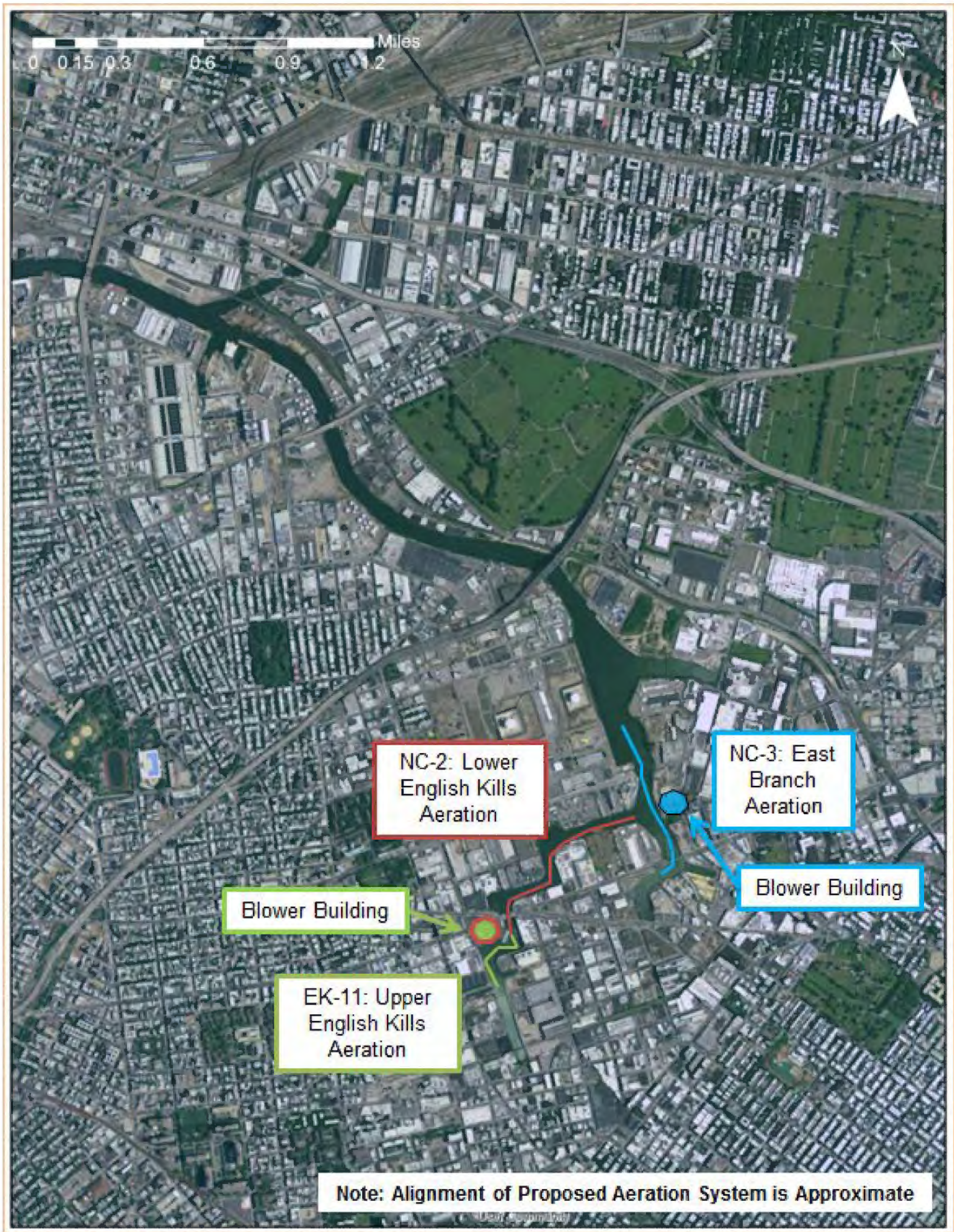

Figure 8-7. In-Stream Aeration at English Kills and East Branch

Additional grey infrastructure alternatives that were considered in the development of this LTCP are described here.

8.2.a.1 System Optimization - Sewer Enhancements

Sewer enhancements typically include measures to optimize the performance of the sewer system by taking advantage of in-system storage capacity to reduce CSO through automated controls or modifications to the existing collection system infrastructure. Examples include: regulator or weir modifications including fixed and bending weirs; control gate modifications; real time control; and increasing the capacity of select conveyance system components, such as gravity lines, pumping stations and/or force mains. Force main relocation or interceptor flow regulation would also fall under this category. These control measures generally retain more of the combined sewage within the collection system during storm events. The benefits of retaining this additional volume must be balanced against the potential for sewer back-ups and flooding, or the relocation of the CSO discharge elsewhere in the watershed or in an adjacent watershed. Viability of these control measures is system-specific, depending on existing physical parameters such as pipeline diameter, length, slope and elevation.

As part of the control measure review process described in Section 8.1, two system optimization measures passed the initial screening process and were subsequently developed and evaluated for Newtown Creek, while other system optimization measures were not carried forward, as described below. The evaluation of floatables control for outfalls BB-009, BB-013, and NCQ-029 is presented at the end of this section.

Fixed Weirs: Regulator improvements were recommended under the 2011 WWFP and resulted in the Regulator Improvement Project. The project evaluated opportunities to improve wet-weather capture and conveyance for treatment at the Newtown Creek WWTP, along with floatables control. To neutralize adverse impacts on the upstream hydraulic grade line, bending weirs were deemed preferable to fixed weirs and are now being installed at the key regulator structures associated with Outfalls BB-026, NC-077, NC-083 and NC-015. As a result of this ongoing work at the four largest CSO outfalls, this control measure was eliminated from further consideration as a stand-alone CSO reduction alternative for this LTCP. However, DEP evaluated relocating overflow between two large outfalls by replacing the existing bending weirs with lower fixed weirs at either Outfall NC-015 or NC-083. These evaluations targeted the potential elimination of a diversion structure, conveyance, and in some cases, a drop shaft, that would no longer be necessary under other CSO reduction alternatives (e.g., tunnel), if the overflows from one of these outfalls could be significantly relocated to the other outfall. These evaluations revealed that little CSO would be relocated from one outfall to the other due to capacity limitations in the existing conveyance piping. For this reason, this concept was not developed further in this LTCP.

Parallel Interceptor/Sewer: Construction of a major near-surface relief pipe parallel to the existing interceptors would have significant constructability and construction impact issues due to the size of the streets, level traffic and density of existing utilities, particularly along the existing Morgan Avenue Interceptor or the Long Island City Interceptor. Trenchless construction would not fully mitigate these challenges. For these reasons, parallel interceptors were not advanced as alternatives. However, other control measures targeting the conveyance of additional combined sewage from the upper end of Newtown Creek watershed to the Newtown Creek WWTP were evaluated. Specifically, a consolidation conduit was evaluated that would run along the northern portion of the watershed, capturing CSO discharges at Outfalls NC-015, NC-083 and NC-077, immediately downstream of the regulators. Because this conduit would convey CSO to a retention/treatment basin (RTB), it is described below as part of Alternative RTB-1, a treatment-based CSO control alternative.

Pumping Station Optimization: In addition to pumping station upgrade or expansion (see below), the operation of a station could also be evaluated to ensure that it is optimized with respect to its ability to maximize the amount of wet-weather flow that is controlled (treated or stored). For example, as noted above, two pumping stations feed flow to the Newtown Creek WWTP, and the adjustment of the rate of pumped flow from one (e.g., Manhattan Pumping Station) would affect the flow amount of flow that could be pumped from the other (e.g., BQPS). However, as also noted under the “Pumping Station Modification” alternative above, interceptor capacity would limit the CSO reduction benefit from increasing the BQPS capacity. As a result, the LTCP evaluations focused on optimizing the Kent Avenue interceptor gate controls, seeking to maximize the flow from the Morgan Avenue interceptor that enters the BQPS wet well. Because the conveyance capacity of the Morgan Avenue interceptor, through which the regulated flow from Outfalls NC-077, NC-083 and NC-015 is conveyed, is limited to approximately 211 MGD, further throttling of the Kent Avenue Gate would not allow more flow from the Morgan Avenue interceptor to reach the pumping station wet well. Consistent with the analyses conducted in the WWFP, the LTCP evaluations concluded that pumping station optimization alone, without significant conveyance relief works along the Morgan Avenue interceptor system, would not result in CSO reduction at Outfalls NC-015, NC-083 and NC-077. Therefore, this CSO measure was not considered further in this LTCP.

Pumping Station Upgrade/Expansion: The 3-MGD Borden Avenue Pumping Station (BAPS) is located adjacent to Dutch Kills on the north side of Newtown Creek. The pumping station serves a relatively small tributary area, and discharges flow to the Long Island City Interceptor (LICI) for conveyance to the Bowery Bay WWTP. The BAPS is currently a candidate for a state of good repair (SOGR) intervention, and the design of the SOGR upgrade was already underway during development of this LTCP. Independently, an alternative was identified whereby the overflow from Outfall BB-026 would be diverted to a wet-weather pumping station, and the discharge routed to a location across Newtown Creek to a point just upstream of the Kent Avenue Gate. Because the location of the wet-weather pumping station would be in the same general vicinity as the BAPS, expanding the BAPS to include additional wet-weather flow capacity presented an opportunity for synergy between the SOGR needs and CSO control. This specific pumping station upgrade/expansion is considered further in this LTCP and is evaluated as Alternative SO-1, described below.

Alternative SO-1: Borden Avenue Pumping Station Upgrade/Expansion

This alternative would involve the following elements (Figure 8-8):

- A new diversion chamber with tide gate constructed on the existing BB-026 outfall downstream of the existing regulator.
- Approximately 2,500 linear feet (LF) of gravity conveyance piping from the new diversion structure to the BAPS.
- Expansion of the BAPS to include additional wet-weather flow capacity.
- Approximately 4,350 LF of new force main from the BAPS to a location just upstream of the Kent Avenue Gate Structure, adjacent to the Newtown Creek WWTP. Two potential alternative routes for the force main are shown in Figure 8-8.

Under this alternative, dry-weather flow would continue to be pumped to the LICI similar to current operation. Under wet-weather conditions, when overflow is diverted from the BB-026 outfall, all flow from the BAPS would be discharged to the new force main. The flow that is discharged just upstream of the Kent Avenue Gate would partially displace flow from regulators associated with outfalls that discharge to the East River from the Newtown Creek WWTP system, resulting in an increase in CSO discharge to the East River. Modeled tracer studies and analysis of flow direction in the pipes indicates that none of the flow pumped from the BAPS would discharge to the East River.

For the 75 percent CSO control alternative, CSO volume will be reduced by about 110 MGY in Dutch Kills, but the additional flow at the Newtown Creek WWTP will displace approximately 80 MGY of CSO into the East River. The overall increase into the East River represents a nine percent increase above the current baseline projection of 848 MGY. Figure 8-9 shows the locations of the East River CSOs where the overflow volume would increase. As indicated in Figure 8-9, a number of GI projects are planned for the general vicinity of Outfall NC-014, where the greatest increase in volume would occur. Other potential options to mitigate the impact of the increased overflow volumes at those outfalls will be investigated under the City-wide/Open Waters LTCP.

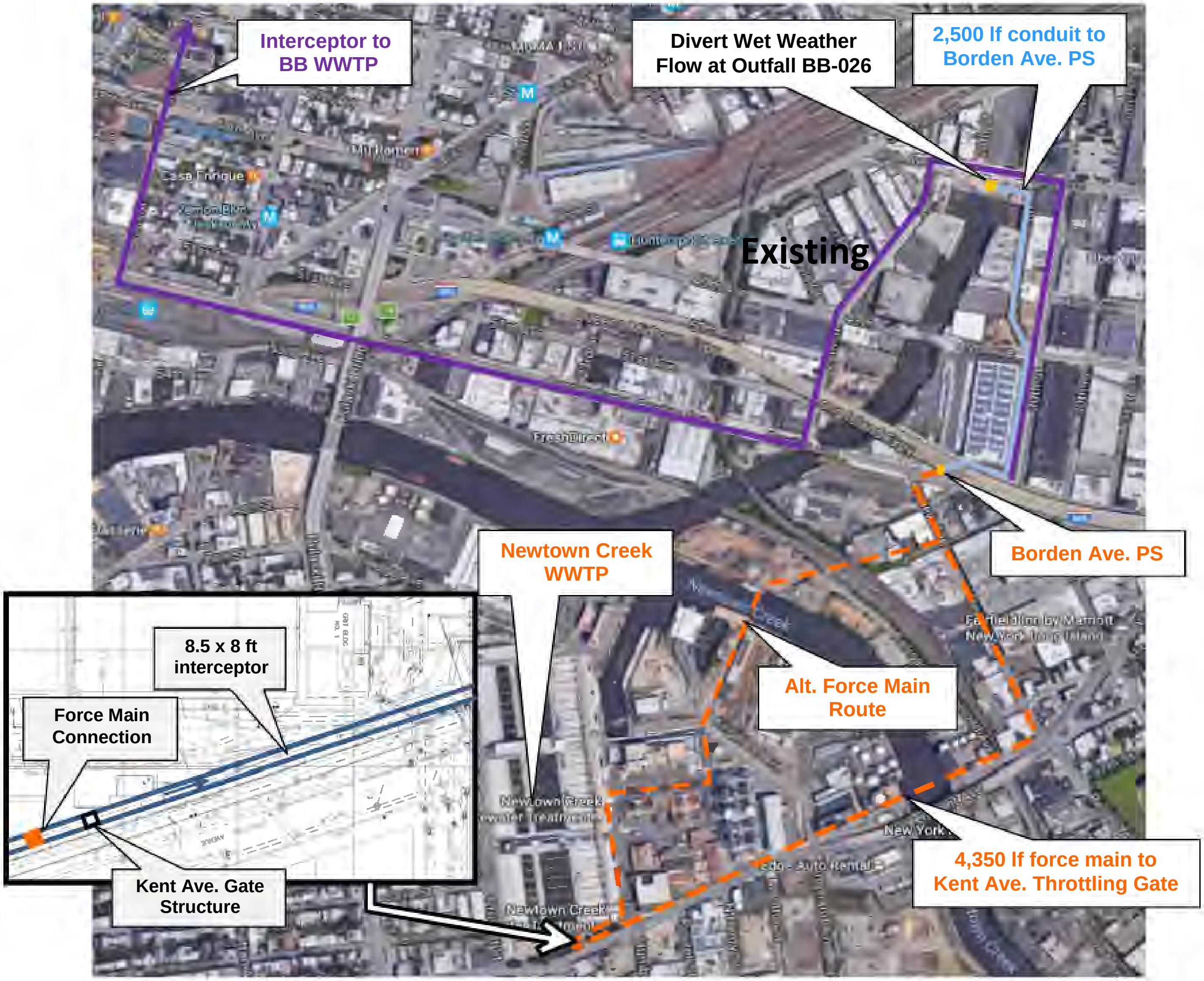

Figure 8-8. Borden Avenue Pump Station Upgrade/Expansion Layout

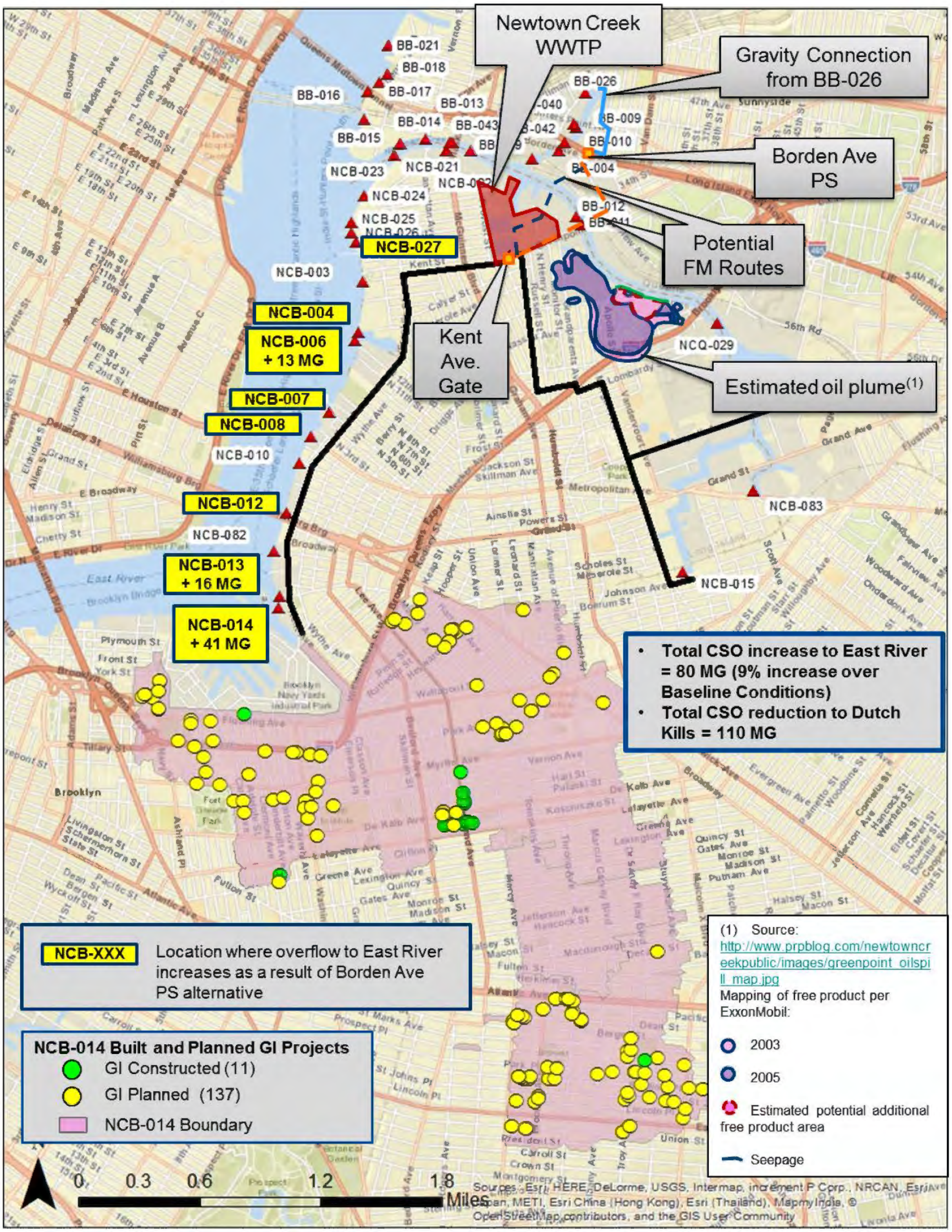

Figure 8-9. Locations of Increase in East River CSO Volume with 75 Percent CSO Control BAPS Expansion Alternative

Diverting wet-weather flow from Outfall BB-026 also results in a reduction in overflow at other CSO outfalls in the Bowery Bay low level system. Most of the additional reduction occurs at Outfall BB-009, in Dutch Kills, while more nominal reductions occur at other Bowery Bay outfalls along Newtown Creek and the East River. Total flow to the Newtown Creek WWTP is increased with this alternative, and total flow to the Bowery Bay WWTP is slightly decreased with this alternative.

The BAPS wet-weather expansion alternative was evaluated for 25, 50, and 75 percent control of the annual discharge from Outfall BB-026. The pumping capacity for 100 percent control would have been over 100 MGD, which would have required a new stand-alone pumping station, significantly increased the volume of overflow to the East River, and potentially have had adverse impacts on the hydraulic grade line in the Kent Avenue system. For these reasons, the 100 percent CSO control option for the BAPS wet-weather expansion was not pursued further.

Table 8-3 summarizes the additional wet-weather flow pumping capacity, force main diameter, and gravity influent sewer diameter associated with the 25, 50 and 75 percent CSO control alternatives for the BAPS expansion.

Table 8-3. Summary for Alternative SO-1

Parameter	Targeted BB-026 Level of Control		
	25%	50%	75%
Additional Wet Weather Flow Pumping Capacity (MGD)	6	13	24
Force Main Diameter (ft)	1.5	2	3
Gravity Conduit Diameter (ft)	2	3	3.5
Net Present Worth ($M)	51	59	71

AECOM with Hazen

An individual CSO storage alternative such as a retention tank would require property acquisition through either negotiated acquisition or eminent domain acquisition of developed parcels to provide equivalent levels of control. The maximum annual CSO control that could be implemented with a retention tank without negotiated acquisition or eminent domain land acquisition would be approximately 20 percent. As such, expansion of the BAPS is the only control measure considered throughout the LTCP for developing alternatives up to 75 percent level of control at Outfall BB-026. For 100 percent control, reduction of the discharges from BB-026 would be realized by conveying the flows to a basin-wide solution (i.e., a CSO storage tunnel) that would also capture CSO from the three large upstream Outfalls NC-077, NC-083 and NC-015.

The benefits, costs and challenges associated with the BAPS wet-weather expansion are as follows:

Benefits

Without further site acquisition, this control measure provides up to 75 percent annual CSO control at Outfall BB-026 at a relatively low cost and provides synergies with a SOGR intervention.

Cost

The estimated NPW for this control measure varies by level of control as follows:

- 25 percent CSO control: $51M
- 50 percent CSO control: $59M
- 75 percent CSO control: $71M

Details of the estimate for 75 percent CSO control are presented in Section 8.4. As noted above in Section 8.1, the WQ assessments indicated that the Class SD DO criterion is currently being met in Dutch Kills and the main trunk of Newtown Creek under baseline conditions. Therefore, the previously-proposed Dutch Kills aeration system is recommended to be eliminated. The Engineer's estimated construction bid cost for Phase 4 of Enhanced Aeration covering Dutch Kills and part of lower Newtown Creek was $30.8M. This cost savings would partially offset the cost of the Borden Avenue Pump Station expansion alternative.

Challenges

The challenges associated with this alternative would include:

- Increased CSO volume to the East River.
- Potential construction site constraints due to the location of the Borden Avenue Pumping Station under the highway bridge.
- The force main to the Kent Avenue Gate Structure will need to pass under Newtown Creek, through bulkheads along the shore of Newtown Creek, and under the Long Island Rail Road (LIRR) tracks. Dense utilities will be encountered along Greenpoint Avenue in the vicinity of the Kent Avenue gate.
- The need to maintain the function of the Borden Avenue Pumping Station during construction.
- The potential for interferences with Superfund remedy work related to dredging and/or bulkhead reconstruction.
- The construction of the diversion conduit and force main would require approval of construction within road rights-of-way to be coordinated with the Department of Transportation (DOT).

Floatables Control for Outfalls BB-009, BB-013, and NCQ-029

Sizing Criteria

Figure 8-9a presents a schematic representation of a typical underflow baffle installation for floatables control at a CSO regulator. The intent of the underflow baffle is to retain floating material during the period of time that the hydraulic grade line in the regulator is above the elevation of the overflow weir, minimizing the discharge of floatables during CSO activations. Once the wet weather flows recede, the floatables held behind the baffle would be conveyed to the interceptor through the dry weather underflow connection. Key sizing criteria related to underflow baffle performance include:

- Offset between the bottom of the baffle and the overflow weir crest
- Flow velocity under the baffle during CSO activations
- Headloss created by the underflow baffle

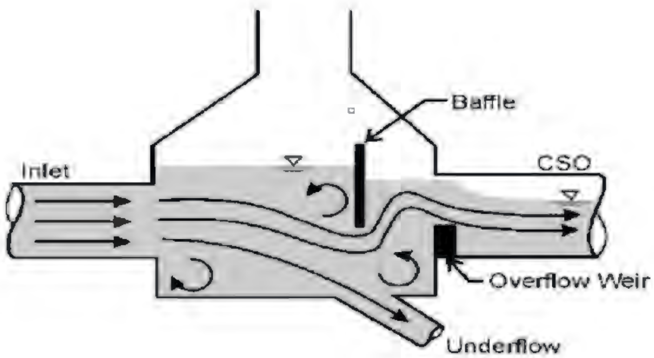

Figure 8-9a. Conceptual Underflow Baffle

For the first two criteria, sizing values were taken from a study of underflow baffle performance conducted at the Alden Research Laboratory in support of the design of underflow baffles and bending weirs for outfalls BB-026, NC-015, NC-077 and NC-083 in the tributaries to Newtown Creek. The findings of that study were summarized in Memoranda dated January 20, 2014[1] and February 27, 2014[2]. The bending weirs and baffles associated with that study have been constructed and are part of the Baseline Conditions for the Newtown Creek LTCP.

The Alden study showed that the floatables retention percentage dropped from about 80 percent to about 50 percent if the velocity under the baffle increased from 1.0 to 1.75 feet per second (ft/sec). To avoid sizing the underflow baffles based on relatively short and infrequent increments of peak flow, the baffles for outfalls BB-009, BB-013, and NCQ-029 were sized to achieve 1 ft/sec at the 90th percentile flow in the 2008 typical year.

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[1] *F. Visingardi, O'Brien & Gere/Dewberry JV, to R. DeLorenzo, regarding CS-NCLFO-DES Floatables Retention Efficiency, 1/20/14.*
[2] *F. Visingardi, O'Brien & Gere/Dewberry JV, to R. DeLorenzo, regarding CS-NCLFO-DES Floatables Retention Efficiency, 2/27/14.*

With regard to baffle submergence relative to the weir crest elevation, the Alden study showed that for an offset of 1.0 foot, the floatables retention percentage was just over 75 percent, while for offsets ranging from 0.25 to 0.75 feet, the floatables retention percentage remained relatively constant at just under 75 percent. When the offset was reduced to zero, the retention percentage dropped to under 50 percent. Based on these findings, the offset between the bottom of the baffle and the weir crest for the baffles for outfalls BB-009, BB-013, and NCQ-029 was assumed to be 0.25 feet.

Regarding the headloss created by the underflow baffle, it was assumed that no increase in the baseline peak HGL in the DEP's 5-year, 2-hour design storm upstream of the regulator would be allowed. Thus, the calculated increase in headloss associated with the underflow baffle in the 5-year, 2-hour storm would have to be offset by physical modifications to the regulator that reduced the headloss by an equivalent magnitude.

Given the complex arrangement and hydraulics within the regulators associated with outfalls BB-009, BB-013, and NCQ-029, it is recommended that computational fluid dynamics (CFD) modeling be conducted to confirm the headloss calculations and sizing as part of pre-design planning activities for these outfalls. Subsurface conditions, utility survey, and other site investigations would also be needed to confirm the constructability of the regulator modifications.

Outfall BB-009 (Regulator BBL-3B)

Outfall BB-009 discharges to Dutch Kills. Regulator BBL-3B is located upstream of outfall BB-009, at the intersection of Hunters Point Avenue and 30th Street (Figure 8-9b). The influent combined sewer to Regulator BBL-3B is a 9-ft x 4.5-ft reinforced concrete sewer. The regulator overflows to an 11-ft x 4.5-ft reinforced concrete outfall pipe, and dry weather flows are conveyed to a 6-ft x 4.5-ft interceptor. The existing overflow weir has a crest elevation of 0.0, and the regulator structure includes twin tide gates. Table 8-3a presents key statistics related to Regulator BBL-3B.

Table 8-3a. Summary of Parameters for Regulator BBL-3B (Outfall BB-009)

Parameter	Value
Annual CSO Volume(1)	43.0 MG
Annual CSO Activations(1)	34
90th Percentile Flowrate (MGD) (1)	25 MGD
Peak HGL in 2008 Typical Year(1)	3.08
Peak HGL in DEP 5-year Design Storm(2)	9.21
Peak Overflow Rate in DEP 5-year Design Storm(2)	315 MGD

Notes:
(1) 2008 LTCP Baseline Conditions
(2) 5-year, 2-hour storm, constant tide of 0.86 ft, LTCP Baseline Conditions

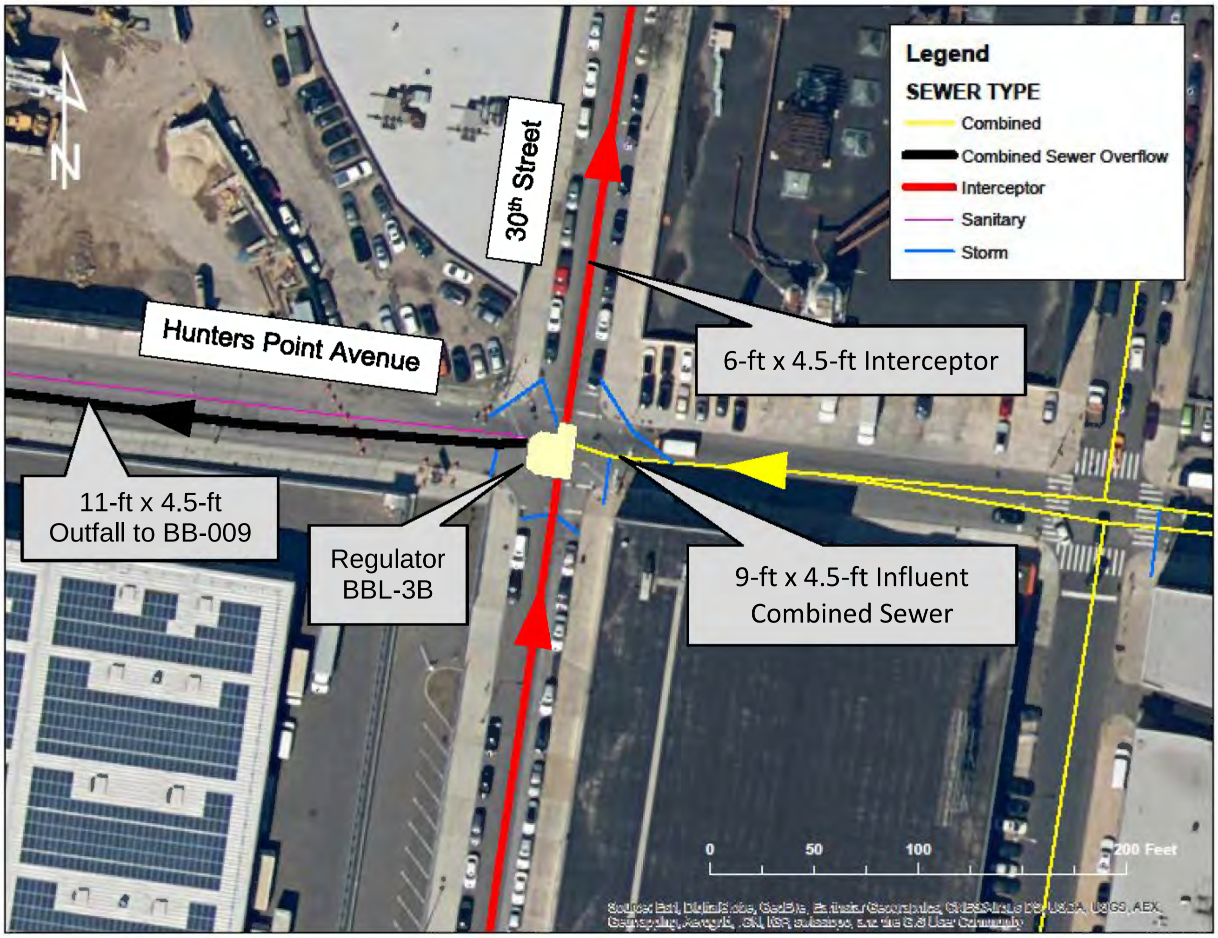

Figure 8-9b. Location of Regulator BBL-3B (Outfall BB-009)

The depth between the weir crest and the invert elevation in the regulator upstream of the weir is only 2.04 feet. In order to achieve the 1.0 ft/sec criterion for the 90th percentile flow with the bottom of the baffle set 0.25 feet below the weir elevation, the weir crest would need to be raised by 0.34 feet. However, when this configuration was assessed with the 5-year, 2-hour storm, the headloss through the regulator was predicted to increase by over 8 feet. Therefore, modifications to the regulator would be needed to offset the predicted increase in headloss associated with the underflow baffle. Through an iterative process, hydraulic neutrality in the 5-year, 2-hour storm was predicted to be achieved through a combination of lengthening the weir and baffle by 6.5 feet, increasing the height of the opening over the weir by 11 inches, and adding a third tide gate. Lengthening the weir and baffle by 6.5 feet would require expanding the existing regulator structure.

Figures 8-9c and 8-9e present the proposed modifications. A bending weir was not considered for this location due to the elevation of the tide relative to the weir crest elevation. The peak high tide in the typical year at this location is approximately elevation 1.5, which is approximately 1.5 feet above the existing weir crest elevation. The modifications to regulator BBL-3B are predicted to reduce the annual activation frequency at outfall BB-009 from 27 to 24, and would increase the annual CSO volume at outfall BB-009 by about 1 MG (due to the reduction in headloss at the outfall during bigger storms). However, the annual volume at the hydraulically-related outfall BB-026 would drop by about 1 MG, resulting in no net change in the total annual volume of CSO to Dutch Kills. No other outfalls in the BBL system would be affected by this project.

Based on a preliminary siting assessment, sufficient space appears to be available in the intersection of Hunters Point Avenue and 30th Street to accommodate the expansion of the regulator structure. Relocation of some utilities may be required. The estimated probable bid cost for this work would be approximately $10M. No significant change in annual O&M cost is anticipated.

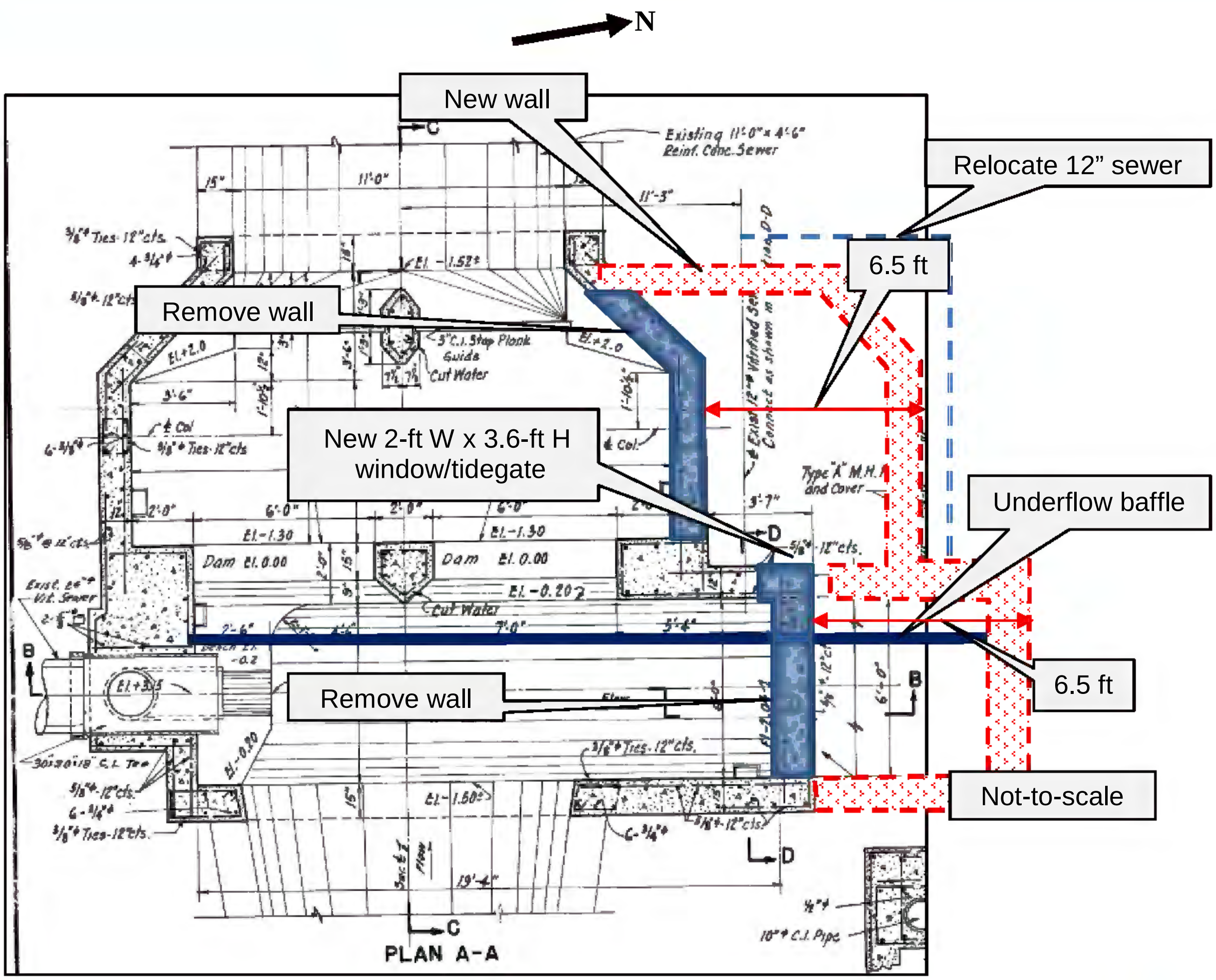

Figure 8-9c. Plan view of regulator modifications for underflow baffle at Regulator BBL-3B (Outfall BB-009)

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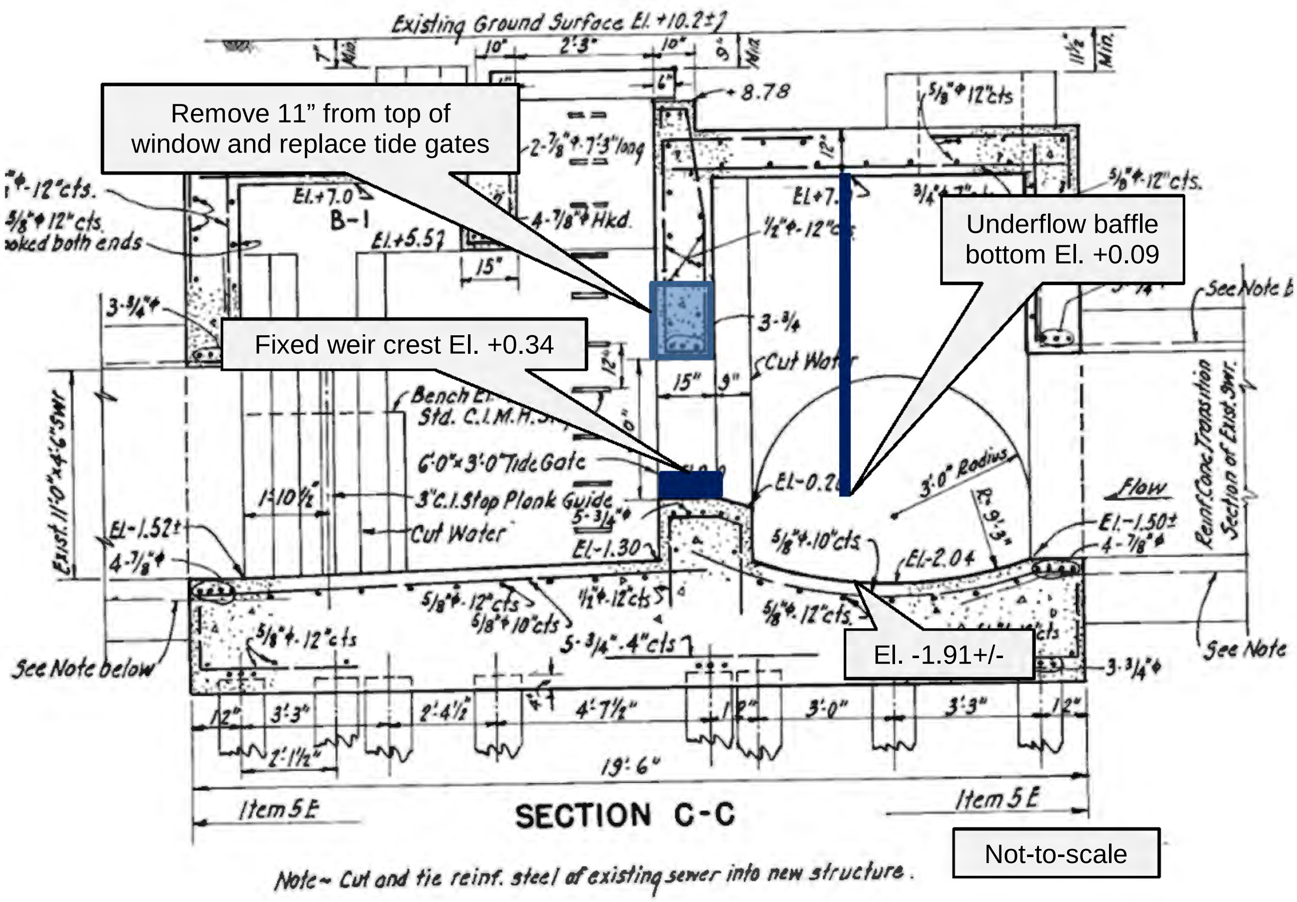

Figure 8-9d. Section view of regulator modifications for underflow baffle at Regulator BBL-3B (Outfall BB-009)

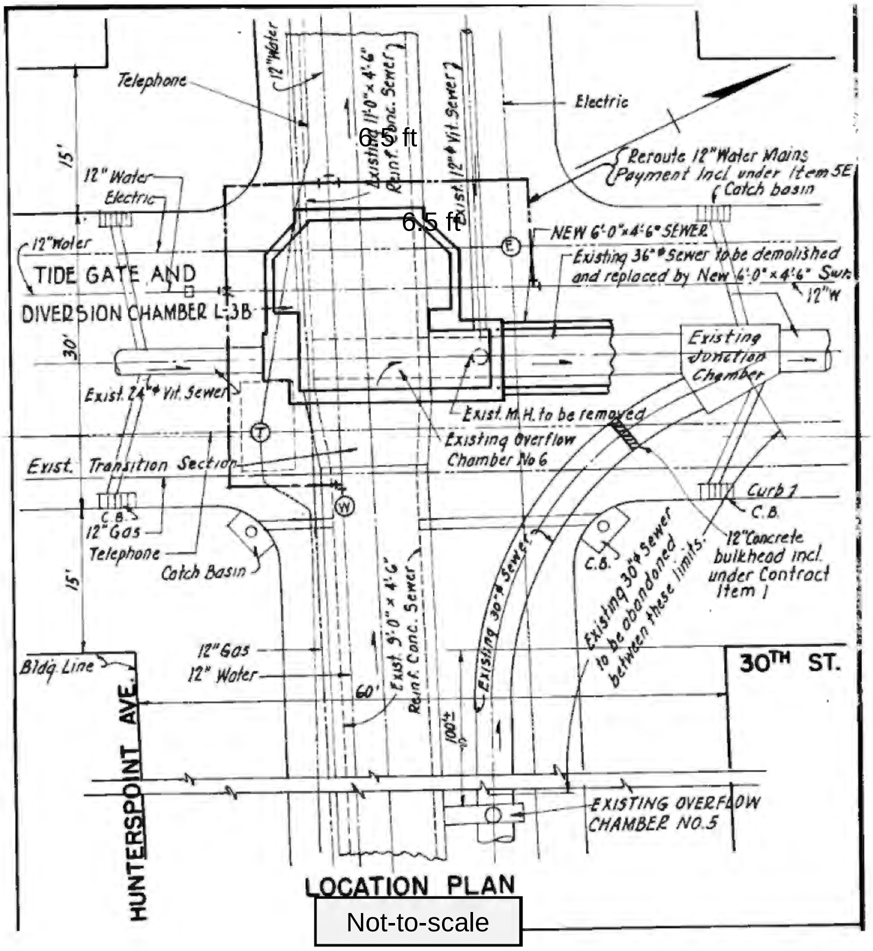

Figure 8-9e. Location plan for regulator modifications for underflow baffle at Regulator BBL-3B (Outfall BB-009)

Outfall BB-013 (Regulator BBL-8)

Outfall BB-013 discharges to Newtown Creek adjacent to the Pulaski Bridge. Regulator BBL-8 is located upstream of outfall BB-013, on 11th Street between 53rd Avenue and Newtown Creek (Figure 8-9f). The influent combined sewer to Regulator BBL-8 is 6-ft diameter. The regulator overflows to a 6-ft diameter outfall pipe, and dry weather flows are conveyed to a 2-ft diameter interceptor. The existing overflow weir has a crest elevation of -5.0, and the regulator structure includes a single tide gate. Table 8-3b presents key statistics related to Regulator BBL-8.

Table 8-3b. Summary of Parameters for Regulator BBL-8 (Outfall BB-013)

Parameter	Value
Annual CSO Volume(1)	16.2 MG
Annual CSO Activations(1)	31
90th Percentile Flowrate (MGD) (1)	7.5 MGD
Peak HGL in 2008 Typical Year(1)	1.76
Peak HGL in DEP 5-year Design Storm(2)	1.46
Peak Overflow Rate in DEP 5-year Design Storm(2)	63 MGD

Notes:
(1) 2008 LTCP Baseline Conditions
(2) 5-year, 2-hour storm, constant tide of 0.86 ft, LTCP Baseline Conditions

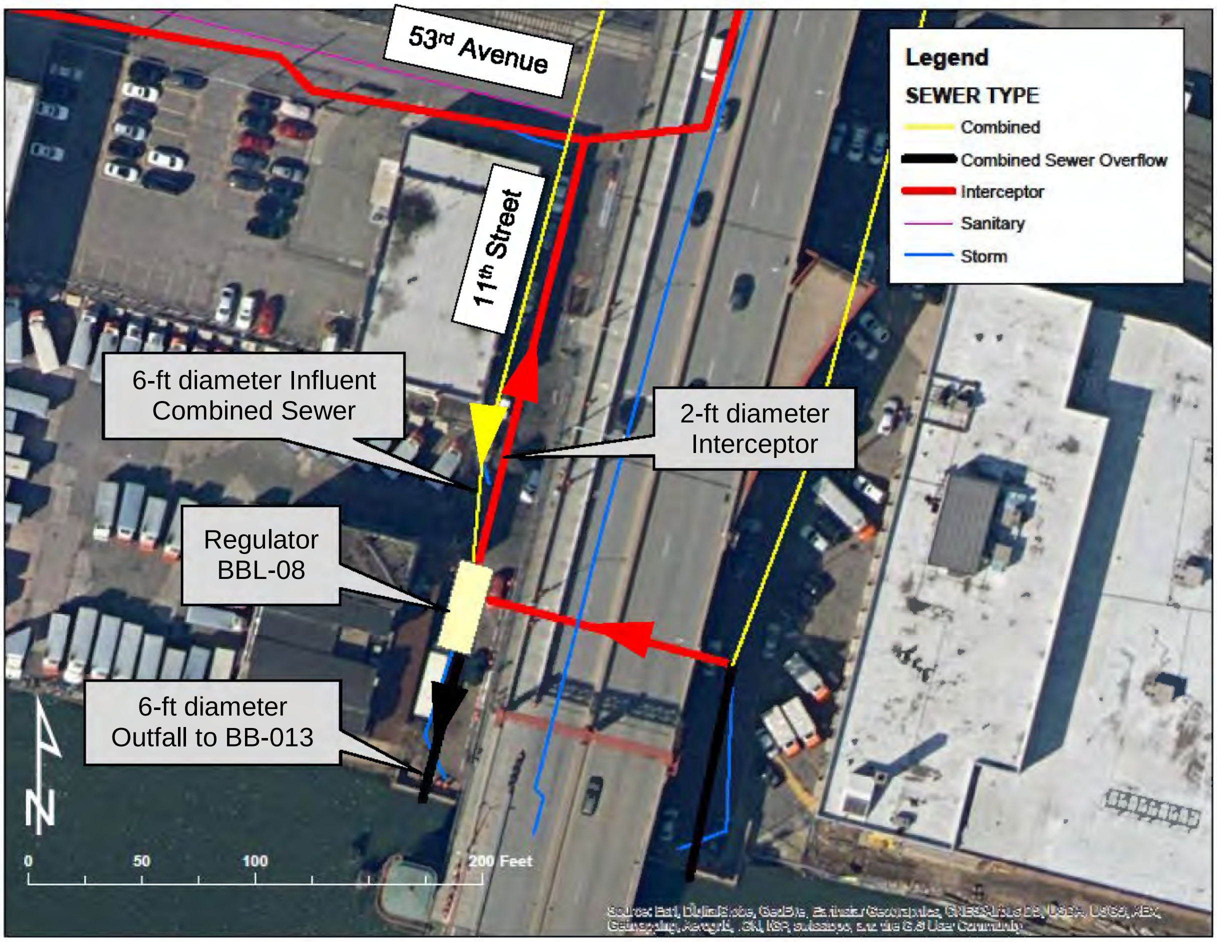

Figure 8-9f. Location of Regulator BBL-8 (Outfall BB-013)

The depth between the weir crest and the invert elevation in the regulator upstream of the weir is only 1.42 feet. In order to achieve the 1.0 ft/sec criterion for the 90th percentile flow with the bottom of the baffle set 0.25 feet below the weir elevation, the weir crest would need to be raised by 0.8 feet. However, when this configuration was assessed with the 5-year, 2-hour storm, the headloss through the regulator was predicted to increase by just under 3 feet. Therefore, modifications to the regulator would be needed to offset the predicted increase in headloss associated with the underflow baffle. Through an iterative process, hydraulic neutrality in the 5-year, 2-hour storm was predicted to be achieved by expanding the regulator/tidegate structure to allow lengthening of the underflow baffle by 8.75 feet, and lengthening the overflow weir by 4.75 feet. A new overflow opening with a new tide gate would be needed to provide the additional 4.75 feet of weir length. These modifications would require the west side of the regulator/tidegate structure to be extended by 8.75 feet. Figures 8-9g to 8-9i present the required modifications. A bending weir was not considered for this location due to the elevation of the tide relative to the weir crest elevation. The peak high tide in the typical year at this location is approximately elevation 1.5, which is approximately 6.5 feet above the existing weir crest elevation.

As indicated in Figure 8-9i, expanding the regulator by 8.75 feet would extend the structure past the building line along 11th Street. Based on a preliminary siting assessment, there does not appear to be sufficient space between the regulator structure and the building line along 11th Street to expand the regulator by 8.75 feet. Expansion on the other side of the structure would not be feasible due to the proximity of the bridge footing and the presence of the adjacent regulator structure. In conclusion, due to siting constraints, an underflow baffle would not be feasible at Regulator BBL-8.

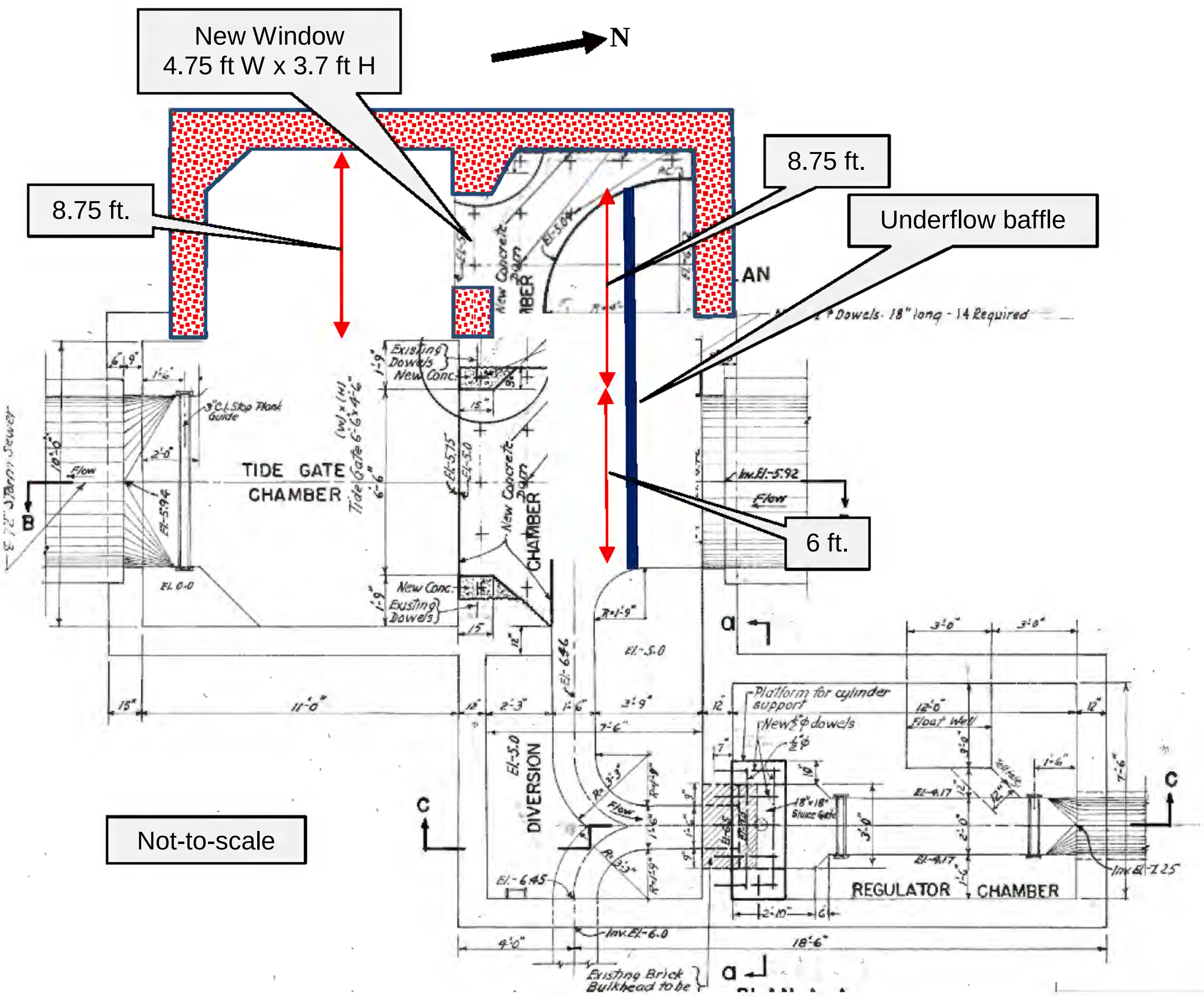

Figure 8-9g. Plan view of regulator modifications for underflow baffle at Regulator BBL-8 (Outfall BB-013)

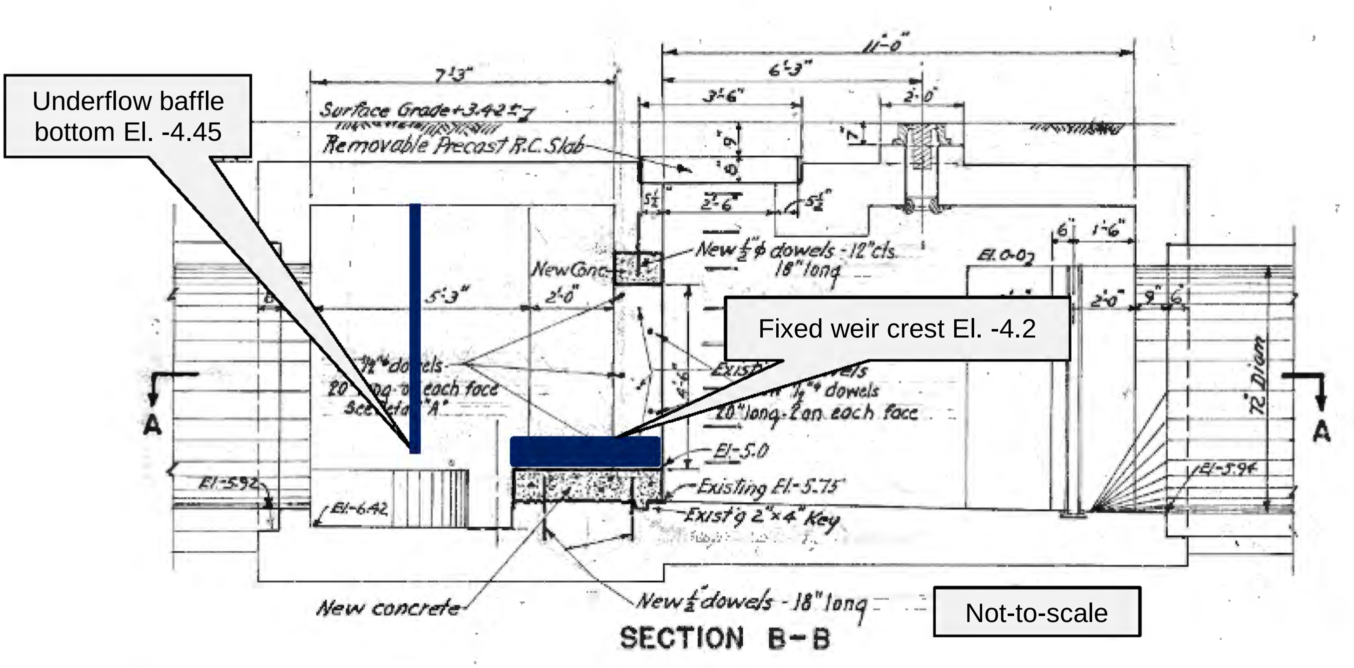

Figure 8-9h. Section view of regulator modifications for underflow baffle at Regulator BBL-8 (Outfall BB-013)

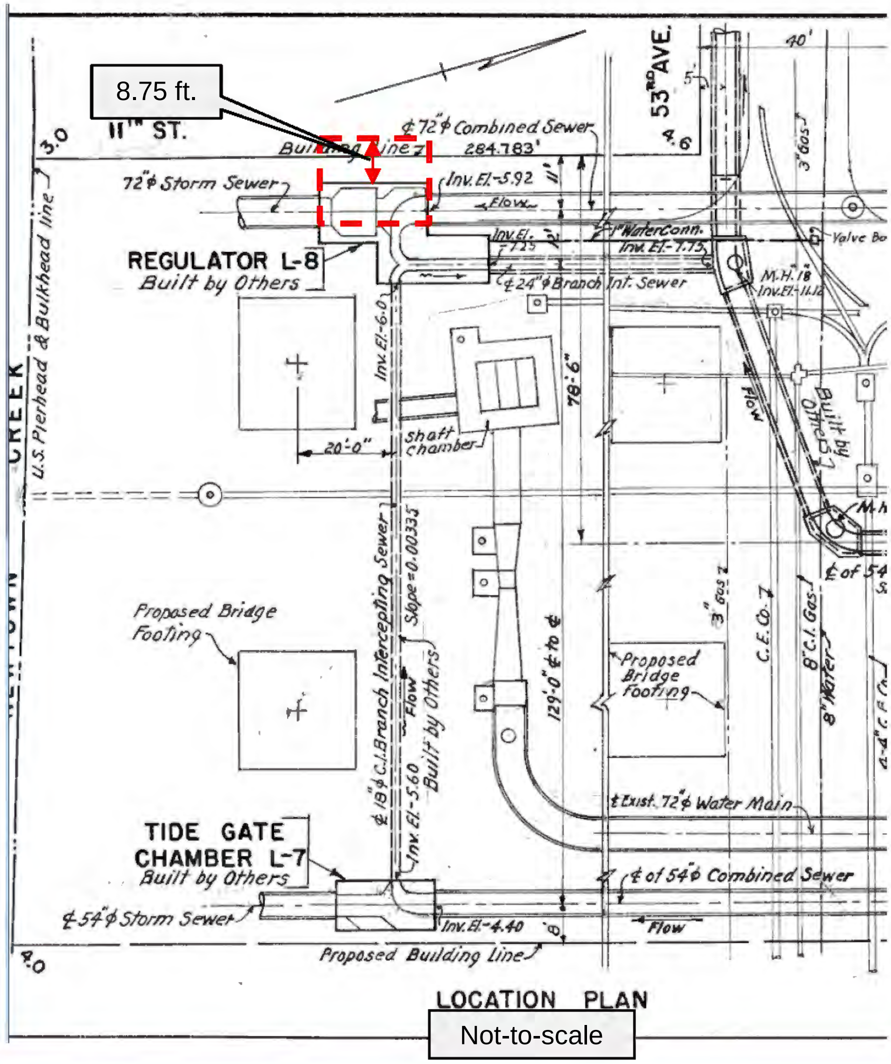

Figure 8-9i. Location plan for regulator modifications for underflow baffle at Regulator BBL-8 (Outfall BB-013)

Outfall NC-029 (Regulator NCQ-2)

Outfall NC-029 discharges to Newtown Creek just downstream of Maspeth Creek. Regulator NCQ-2 is located upstream outfall NC-029, on 43rd Street at 56th Road (Figure 8-9j). The influent combined sewer to Regulator NCQ-2 is a 3.75-ft diameter reinforced concrete sewer. The regulator overflows to a 5.5-ft diameter outfall pipe, and dry weather flows are conveyed to a 1.5-ft diameter combined sewer. The existing overflow weir has a crest elevation of 8.09. Since the weir crest elevation is well above high tide, the regulator structure does not have a tide gate. Table 8-3c presents key statistics related to Regulator NCQ-2.

Table 8-3c. Summary of Parameters for Regulator NCQ-2 (Outfall NC-029)

Parameter	Value
Annual CSO Volume(1)	18.7 MG
Annual CSO Activations(1)	40
90^{th} Percentile Flowrate (MGD) (1)	7.5 MGD
Peak HGL in 2008 Typical Year(1)	10.13
Peak HGL in DEP 5-year Design Storm(2)	12.01
Peak Overflow Rate in DEP 5-year Design Storm(2)	107 MGD

Notes:
(1) 2008 LTCP Baseline Conditions
(2) 5-year, 2-hour storm, constant tide of 0.86 ft, LTCP Baseline Conditions

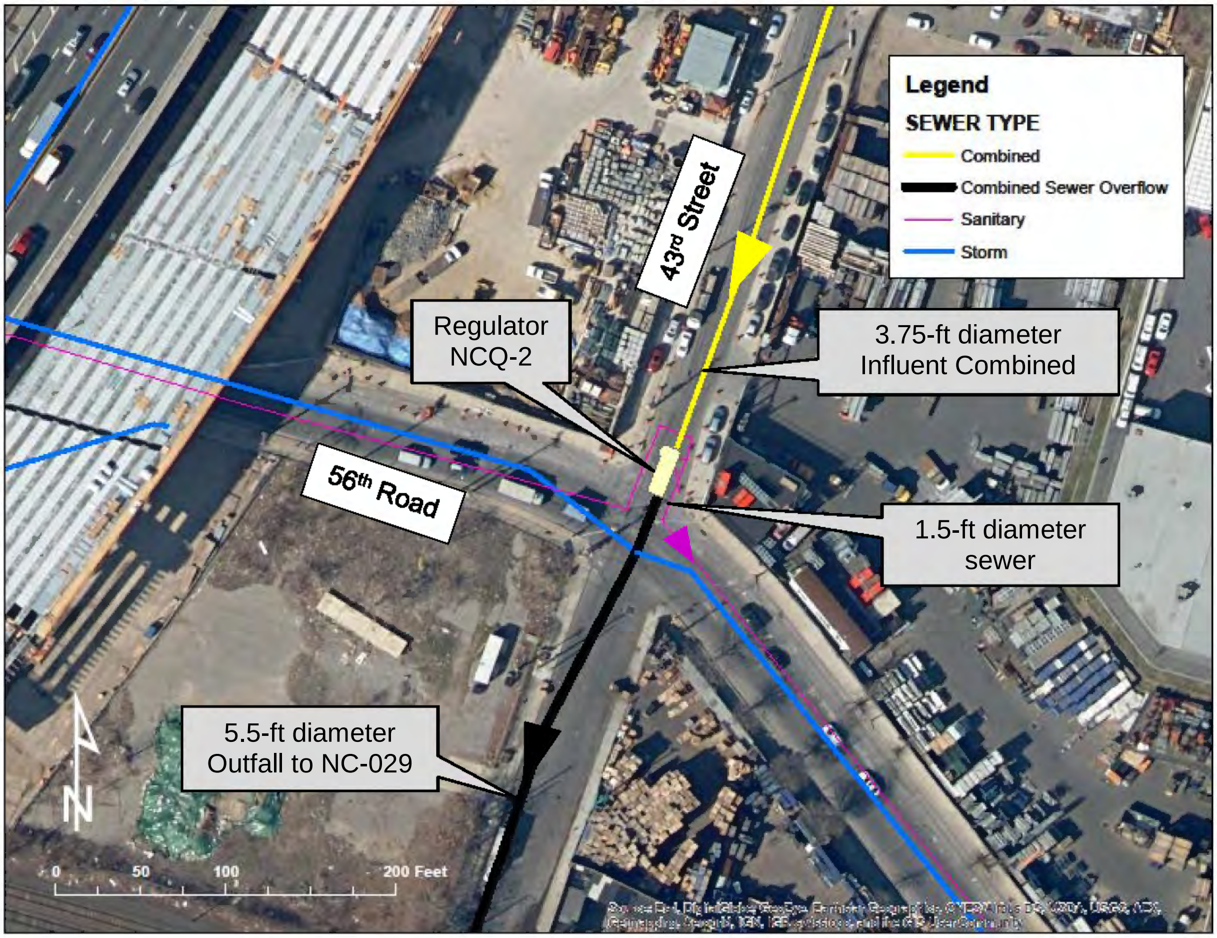

Figure 8-9j. Location of Regulator NCQ-2 (Outfall NC-029)

The depth between the weir crest and the invert elevation in the regulator upstream of the weir is only 1.0 foot. In order to achieve the 1.0 ft/sec criterion for the 90th percentile flow with the bottom of the baffle set 0.25 feet below the weir elevation, the weir crest would need to be raised by 0.7 feet. However, when this configuration was assessed with the 5-year, 2-hour storm, the headloss through the regulator was predicted to increase by over 10 feet. Therefore, modifications to the regulator would be needed to offset the predicted increase in headloss associated with the underflow baffle. Since the existing weir crest elevation is not influenced by the tide, a bending weir was considered as an option to reduce the needed lengthening of the weir. Through an iterative process, hydraulic neutrality in the 5-year, 2-hour storm was predicted to be achieved by expanding the regulator structure to allow lengthening of the underflow baffle by 7.5 feet, and providing a 1.25-foot high, 15.5-foot long bending weir. These modifications would require the west side of the regulator structure to be extended by 7.5 feet, with an additional 12 feet added for the counterweight chamber. Figures 8-9k to 8-9m present the proposed modifications. The modifications to regulator NCQ-2 are predicted to reduce the annual activation frequency at outfall NC-029 from 40 to 37, and would decrease the annual CSO volume at outfall NC-029 by about 0.7 MG. No other outfalls in the Newtown Creek WWTP system would be affected by this project.

Based on a preliminary siting assessment, sufficient space appears to be available in the intersection of 56th Road and 43rd Street to accommodate the expansion of the regulator structure. However, it appears that relocation of a 12-inch sewer, along with water, gas and electric utilities would be required. If a counterweight chamber is required for the bending weir, there may not be sufficient space between the new structure and the edge of the right-of-way to relocate those utilities. If an alternative type of bending weir is provided that does not require the counterweight structure, then it may be feasible to relocate those utilities within the right-of-way. A more detailed utility survey and evaluation of bending weir types will be needed in order to confirm the feasibility of this alternative. If feasible, the estimated probable bid cost for this work would be approximately $15M. The annual O&M cost is estimated at $36,400/year, and the NPW would be $15.5M.

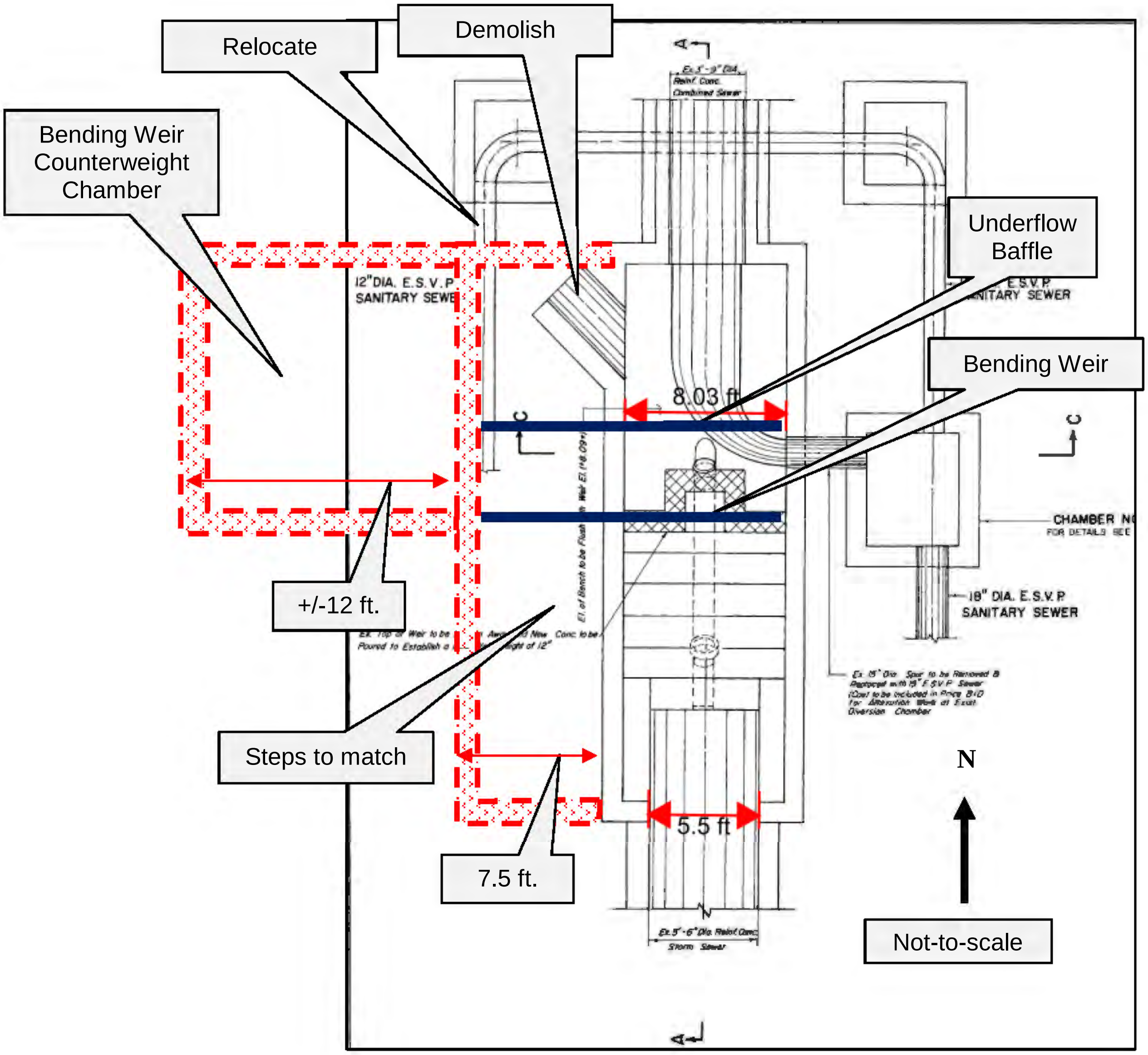

Figure 8-9k. Plan view of regulator modifications for underflow baffle at Regulator NCQ-2 (Outfall NC-029)

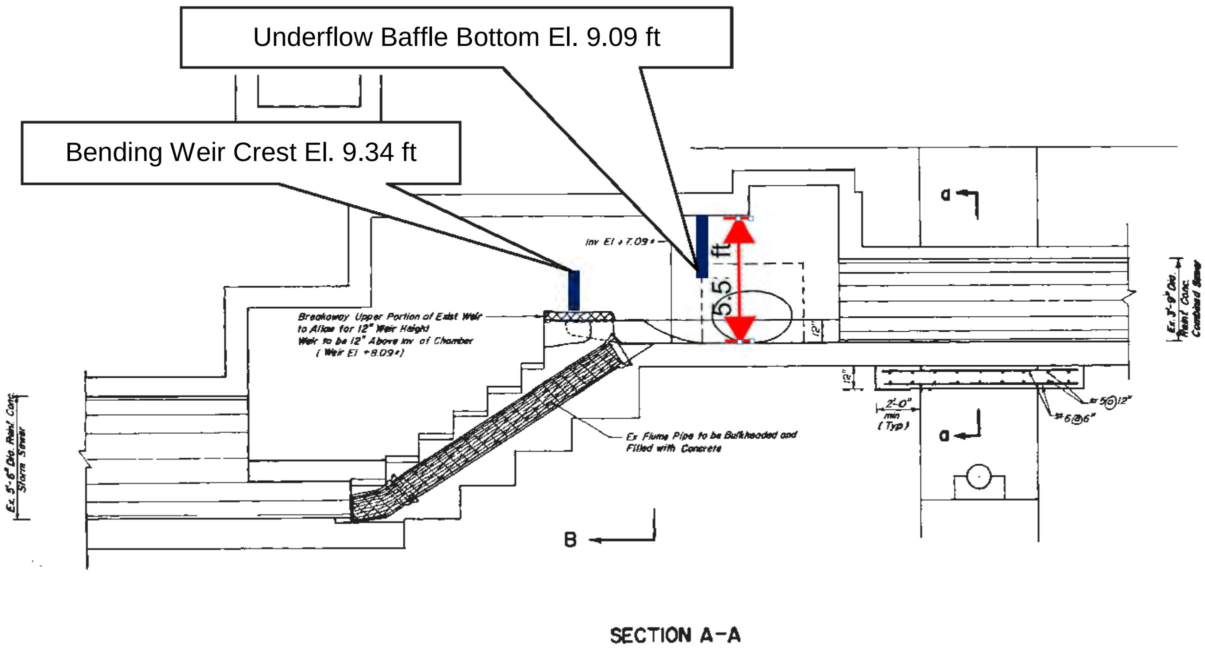

Figure 8-9l. Section view of regulator modifications for underflow baffle at Regulator NCQ-2 (Outfall NC-029)

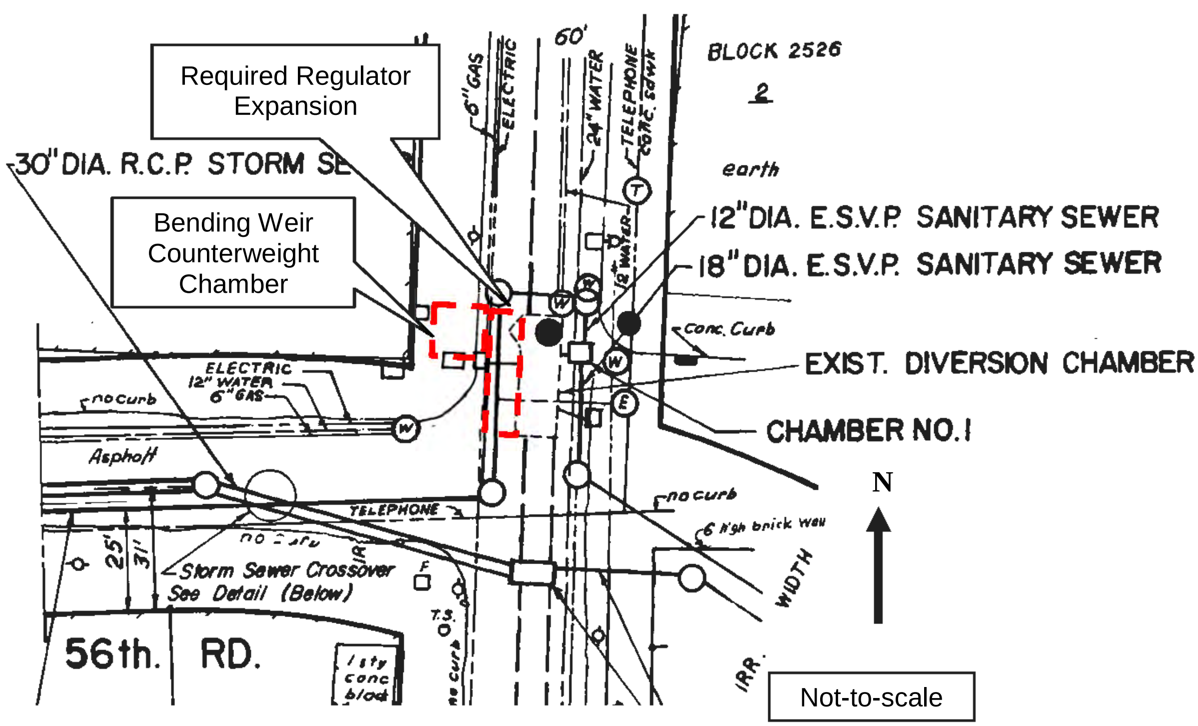

Figure 8-9m. Location plan for regulator modifications for underflow baffle at Regulator NCQ-2 (Outfall NC-029)

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Summary of Floatable Control Evaluation

Table 8-3d summarizes the findings of the evaluation of underflow baffles for floatables control at outfalls BB-009, BB-013, and NCQ-029. In terms of reduction in overall floatables loadings to Newtown Creek, it is noted that the Recommended Plan for Newtown Creek will reduce the CSO volume (and associated floatables load) from outfalls NC-15, NC-77 and NC-83 by 62.5 percent, and from outfall BB-026 by 75 percent. Of the 449 MG/yr of CSO to Newtown Creek remaining after implementation of the Recommended Plan, 359 MG (80 percent) will occur at outfalls NC-15, NC-77, NC-83 and BB-026, where the bending weirs and underflow baffles currently installed at the regulators associated with those outfalls will control floatables for the remaining discharges. Outfalls BB-009 and NCQ-029 represent 10 percent (46 MG) of the remaining 449 MG of CSO to Newtown Creek, leaving 44 MG (10 percent) without structural floatables control. However, DEP's BMP programs, including hooded catchbasins, catchbasin cleaning, street sweeping, and public engagement on litter control, will contribute to controlling floatables at those remaining outfalls. In accordance with direction from DEC, a floatables monitoring program will be implemented at outfalls BB-009 and NCQ-029 to determine whether the structural floatables control alternatives developed for those two outfalls will be required to be implemented.

Table 8-3d. Summary of Floatable Control Evaluation for Outfalls BB-009, BB-013, and NCQ-029

Outfall/Regulator	Modifications Required for Floatables Control with Hydraulic Neutrality(1)	Implementation Feasible?(2)	Estimated Probable Bid Cost
Outfall BB-009; Reg. BBL-3B	• Raise the static weir by 0.34 feet • Expand the north side of the structure by 6.5 feet • Lengthen the static weir by 6.5 feet • Provide an underflow baffle with bottom set 0.25 feet below the weir crest, extending the length of the weir • Increase the height of the opening over the weir by 11 inches • Add a third tide gate	Yes	$10 M
Outfall BB-013, Reg. BBL-8	• Raise the static weir by 0.8 feet • Expand the west side of the structure by 8.75 feet • Provide a new 4.75-foot wide overflow weir with a tide gate • Provide an underflow baffle with bottom set 0.25 feet below the weir crest, extending the length of the existing and new weir	No	N/A(3)

Table 8-3d. Summary of Floatable Control Evaluation for Outfalls BB-009, BB-013, and NCQ-029

Outfall/Regulator	Modifications Required for Floatables Control with Hydraulic Neutrality(1)	Implementation Feasible?(2)	Estimated Probable Bid Cost
Outfall NCQ-029, Reg. NCQ-2	• Provide a 1.25-foot high, 15.5-foot long bending weir • Expand the west side of the structure by 7.5 feet to accommodate the bending weir • Provide a counterweight chamber next to the expansion on the west side of the structure • Provide an underflow baffle with bottom set 0.25 feet below the weir crest, extending the length of the bending weir	Needs more detailed assessment to confirm utility relocations	$15 M

8.2.a.2 CSO Relocation

Gravity Flow Tipping to Other Watersheds: This concept would involve conveying overflows by gravity from one receiving water to another receiving water, where the second receiving water would either be less sensitive or provide greater dilution/assimilation than the one from which the CSO is being diverted. A number of potential gravity flow tipping alternatives were identified and initially evaluated, but none were determined to provide significant opportunity to warrant pursuing this solution further. Options evaluated included the following:

Diversion from NCB-015 to NCB-014. Gravity diversion of flows was evaluated across the boundary between the subcatchments of outfalls NCB-015 and NCB-014, which discharge to Newtown Creek and the East River, respectively. A subsequent analysis of the conveyance network and the subcatchment boundaries revealed that the concept would relocate only flows generated by a very limited portion of the NC-015 drainage area, with limited benefit in terms of CSO reduction. As a result, this alternative was eliminated from further consideration.

Diversion from BB-026. Multiple gravity conveyance relief solutions were evaluated for CSO mitigation at Outfall BB-026. These alternatives primarily considered improving conveyance of combined sewage upstream and downstream of Regulator BLL-4 (Outfall BB-026). Multiple discharge locations along the Bowery Bay low level interceptor as well as the headworks of the Bowery Bay WWTP were evaluated. Consistent with the analyses conducted in the June 2011 WWFP, these concepts proved either hydraulically infeasible or extremely challenging to implement due to constructability restraints imposed by the dense transportation network along the potential routes, most notably the LIRR tracks and yard and Metropolitan Transportation Authority subway lines. As a result, these concepts were also eliminated from further consideration.

Morgan Avenue Prioritization. For the direct Newtown Creek WWTP sewershed, assessments were conducted to evaluate potential options to prioritize flow from the Morgan Avenue Interceptor to the plant. The performance gains from the various evaluated concepts were limited by the conveyance capacity of the Morgan Avenue Interceptor. As a result, these CSO relocation concepts for the Newtown Creek WWTP sewershed were also eliminated from further consideration.

Flow Tipping with Conduit/Tunnel and Pumping: This control measure would be similar to gravity flow tipping, but the conveyance of flow to another receiving water would require pumping. This concept was evaluated for Outfall NC-077 as described below.

Alternative CR-1: Alternative SO-1 + New Pumping Station at Outfall NC-077.

A 2.8-acre DEP owned parcel is located adjacent to the alignment of the existing NC-077 outfall and Regulator NCQ-01, providing the potential opportunity to utilize the site for a CSO control facility. One option would be to divert overflow from Outfall NC-077 to a new wet-weather pumping station on that site. The pumping station would discharge the flow through a long force main (9,800 LF) to a location upstream of the Kent Avenue Gate Structure, similar to the concept described above for Outfall BB-026. The required pumping rates for the various levels of control are shown in Table 8-4. Figure 8-10 shows the conceptual layout of Alternative CR-1.

Table 8-4. Summary of Parameters for Alternative CR-1

NC-077 CSO Control	25%	50%	75%
PS Cap.(MGD)	14	35	75
Force Main Diameter (ft)	2.5	3.5	5

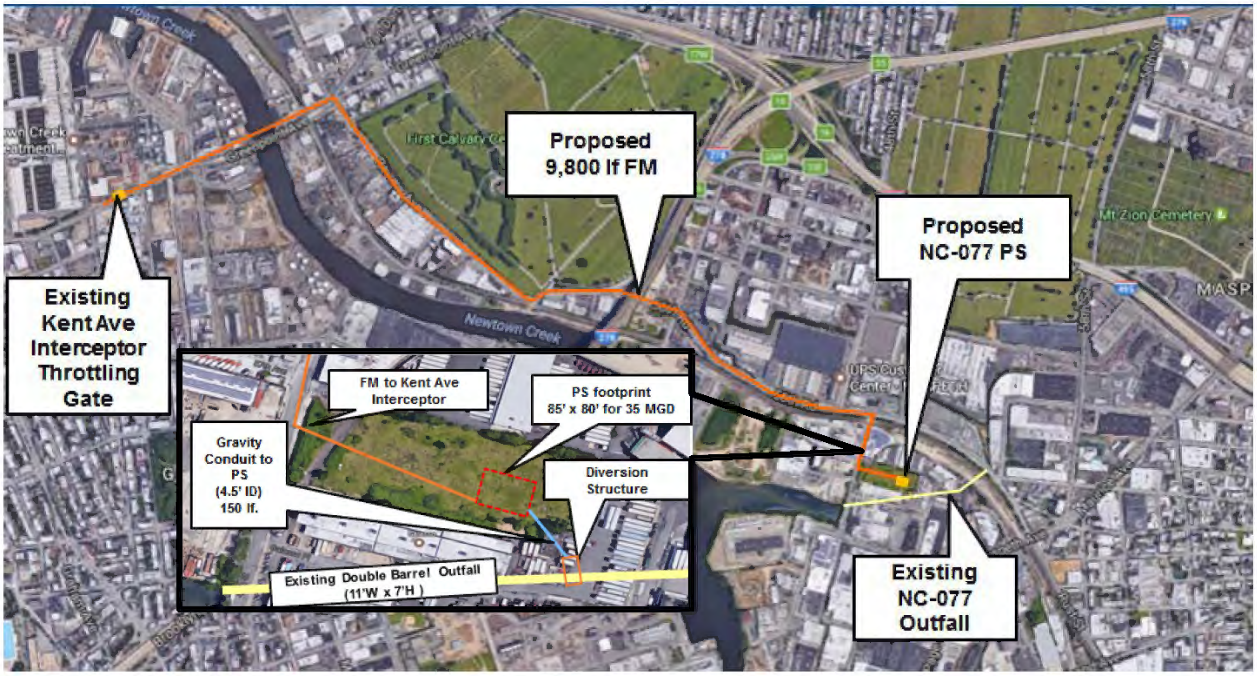


Figure 8-10. Layout of New Pumping Station at Outfall NC-077 part of Alternative CR-1

As with the BAPS alternative for Outfall BB-026, the pumping rate required to achieve 100 percent CSO control at Outfall NC-077 was excessive (482 MGD), so the 100 percent control option for this alternative was not evaluated further. Because of the large force main diameter required for the 75 percent level of control, and the cumulative impacts of this alternative with the BAPS alternative (SO-1) on the Kent Avenue interceptor performance, only the 50 percent CSO control option was evaluated further. Even at the 50 percent control level, the volume of additional overflow at the East River outfalls upstream of the Kent Avenue gate would further increase over the values presented for Alternative SO-1. The total increase in overflow volume to the East River for this alternative would be 187 MG, with a 100-MG increase at Outfall NC-014 alone.

<u>Benefits</u>

CSO discharges would be reduced from Maspeth Creek, a tributary with poor tidal exchange.

<u>Cost</u>

The preliminary estimated NPW for this control measure is $114M for 50 percent CSO control.

<u>Challenges</u>

The challenges associated with this control measure include:

- Although DEP owns the site of the proposed pumping station, other competing needs within DEP may affect the availability of the site for a wet-weather pumping station.

- The measure does not appear to be cost-effective when compared to broader solutions that could also target capture of the two other large CSO outfalls (NC-083 and NC-015) in the headwaters of the Creek and would result in increased CSO discharges at other outfalls.
- The long force main route would require multiple micro-tunneling launching stations with associated siting risks and disruption to the heavy industrial traffic in the neighborhood.
- The significant increase in additional volume discharged at the East River outfalls would likely require mitigation.

8.2.a.3 Water Quality/Ecological Enhancements

The control measures under the category of Water Quality/Ecological Enhancements are not CSO reduction measures but, rather, focus on enhancing the water quality through other approaches. As noted above, floatables control is currently being implemented at the four largest outfalls to Newtown Creek, and mechanical aeration systems have been or are being installed in English Kills and East Branch. Dredging was not considered under this LTCP because EPA is evaluating dredging alternatives for Newtown Creek under the Superfund process. At public meetings conducted during the development of the Newtown Creek LTCP, comments were received that expressed an interest in ecological enhancements/wetlands restoration along the banks of Dutch Kills. Given the existing volumes and peak flows from Outfall BB-026, a wetlands treatment system for Dutch Kills did not appear to be practical. However, wetlands plantings along the banks of Dutch Kills, similar to the pilot installation installed at the head of Dutch Kills, would likely be more feasible. However, the timing of wetlands restoration along the banks of Dutch Kills would depend on the scope and timing of any dredging and/or shoreline work that may be included in the Superfund ROD. For this reason, wetlands restoration along the Dutch Kills shoreline is not included as recommendation in this LTCP.

Flushing tunnels were ruled out for Maspeth Creek, East Branch and English Kills due to the length and cost of a tunnel to convey East River water to those upstream locations. An initial concept for a flushing tunnel was developed for Dutch Kills. This alternative included a 50-MGD pumping station located along Newtown Creek near the mouth of Dutch Kills, and a force main from the pumping station to the head end of Dutch Kills. The cost of this alternative would have been approximately the same as the BAPS wet-weather pumping alternative (SO-1) described above. However, because the flushing tunnel alternative would not have reduced the CSO volume to Dutch Kills, whereas the BAPS alternative would remove up to 75 percent of the annual volume, the flushing tunnel alternative was not pursued further.

The gap analysis presented in Section 6 indicated that for the receiving water stations in and upstream of Dutch Kills (Stations NC-5 to NC-9), the Class SD DO criterion was met more than 95 percent of the time on an average annual basis under baseline conditions. As a result, in-stream mechanical aeration is not recommended for Dutch Kills and the reach of Newtown Creek between Dutch Kills and Station NC-9. However, aeration was deemed to still be needed in English Kills and East Branch.

8.2.a.4 Retention/Treatment Alternatives

A number of the control measures considered for Newtown Creek fall under the dual category of treatment and retention. For purposes of this LTCP, the term “storage” is used in lieu of “retention.” These control measures include in-line or in-system storage, off-line tanks and deep tunnel storage. Treatment refers to disinfection in either CSO outfalls or at RTBs. A discussion of the retention/treatment alternatives evaluated follows.

Evaluation of Retrofitting and Re-purposing of Existing Infrastructure for Retention/Treatment

Initial evaluations focused on maximizing the performance of existing infrastructure to capture and/or treat CSO discharges. Alternative OTF-1 and OTF-2 evaluated opportunities to modify Outfalls NC-077 and NC-083 for outfall storage or disinfection. The lengths of Outfalls NC-015 and BB-026 downstream of the respective regulators were too short to consider for outfall storage or disinfection.

Alternative OTF-1: In-line Storage at Outfalls NC-077 and NC-083

Outfall NC-077 is a 720-foot-long, twin-barrel, 11-ft W x 7-ft H conduit, and Outfall NC-083 is a 1,250-foot-long, 17-ft W x 13-ft H single-barrel conduit. Both outfalls run at a relatively flat slope, and were of sufficient length and size to be considered for outfall storage. Figure 8-11 shows the longitudinal profile for the NC-083 outfall barrel. To modify the outfalls for in-line storage, a weir structure would be required at the downstream end, with a small dewatering pumping station. In small storms, the outfall would fill up to the elevation of the weir, and the stored flow would be pumped back to the interceptor system at the end of the storm. In larger storms, higher flows would overflow the weir and continue to discharge, but at the end of the storm, the flow remaining behind the weir would still be pumped back to the interceptor.

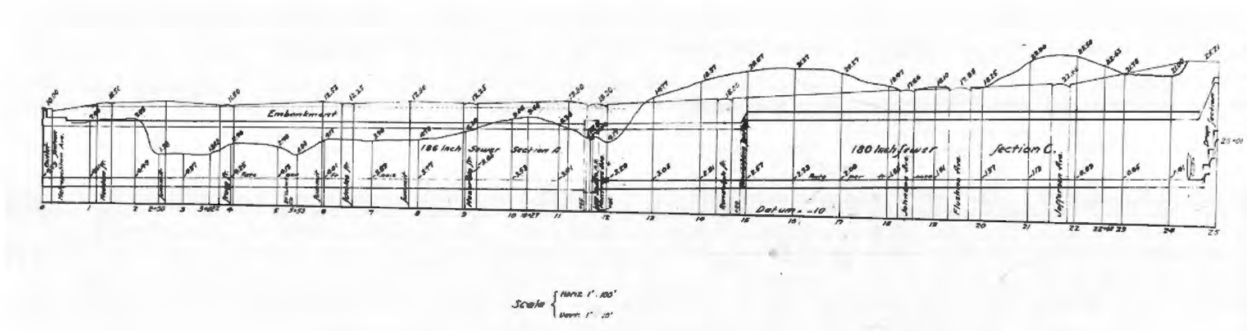


Figure 8-11. Longitudinal Profile of NC-083 Outfall Barrel.

An analysis was conducted to determine the maximum potential CSO reduction that could be achieved through outfall storage at each of these two longer outfall barrels. Table 8-5 summarizes the key characteristics of each outfall and the approximate maximum potential CSO level of control that could be achieved for Outfalls NC-077 and NC-083.

Table 8-5. Key Outfall Characteristics (NC-077 and NC-083)

Parameter	NC-077	NC-083
Length (lf)	720	1,250
Cross-section (W x H)	11 ft x 7 ft	17 ft x 13 ft
Number of Barrels	2	1
Percent Reduction in Annual Volume with Storage Only	2%	2%

As shown in Table 8-5, neither outfall would provide an appreciable amount of in-line storage. To achieve even the levels of storage stated, a number of separate storm drains that connect to the outfalls downstream of the CSO regulator would have to be re-routed. Given the potential costs of this alternative and the limited CSO reduction benefit, this alternative was eliminated from further consideration.

Alternative OTF-1: Disinfection at Outfalls NC-077 and NC-083

Building upon the maximum potential in-line storage volume that could be provided by Alternative OTF-1 at both the NC-077 and NC-083 outfalls, an analysis was also performed of the outfall disinfection opportunities associated with these two long outfalls. The concept for this alternative would be to dose sodium hypochlorite just downstream of the regulator, and use the volume in the outfall for disinfection contact time. Using a 15-minute chlorination contact time, it was determined that the maximum seasonal level of CSO control would not exceed 22 percent for NC-077 and 24 percent for NC-083. Given the limited benefit, together with the cost and complexity of outfall disinfection, this alternative was eliminated from further consideration.

Retention/Treatment Facilities

A review of existing parcels in the vicinity of Outfalls BB-026, NC-077, NC-083 and NC-015 was performed to identify potential sites for retention/treatment facilities. The siting review looked at parcels within a half-mile radius of the CSO regulators associated with each outfall. The initial siting assessment looked for unoccupied sites that did not have existing buildings, while cemeteries, schoolyards and rail yards were excluded as potential sites. The sizes of the unoccupied sites were then compared against the space needed for either a storage tank or RTB to provide 25, 50, 75, or 100 percent CSO control. Smaller sites were also identified for potential locations of tunnel drop shafts. The results of this analysis were as follows:

- Outfall BB-026: one site identified that could provide 25 percent control for a storage tank, or 50 percent control for an RTB
- Outfall NC-077: one site identified that could provide 50 percent control for a storage tank, or 75 percent control for an RTB
- Outfalls NC-083 and NC-015: no sites identified that could provide at least 25 percent control for a storage tank or RTB

Based on the limited number of unoccupied sites identified, the siting assessment was expanded to look at all parcels within a half-mile radius of the CSO regulator, regardless of whether the parcel was occupied by an existing building. Cemeteries, schoolyards and rail yards remained excluded as potential sites. While this approach identified more potential parcels of sizes sufficient to accommodate storage tanks or RTBs at higher levels of CSO control, the challenges of obtaining these sites for CSO storage tanks or RTBs were clearly recognized. Acquisition of these sites would likely be through either a negotiated acquisition or the eminent domain process. Although this process of land acquisition would be highly undesirable and time-consuming, it was necessary to consider this option to develop traditional individual off-line storage tank options for comparison to other consolidated CSO control alternatives (i.e., storage tunnels).

For Outfall BB-026 in Dutch Kills, the BAPS wet-weather expansion alternative described in Section 8.2.a.1 above could provide up to 75 percent control through expansion of the pumping station on the existing pumping station site. Given the high level of control achievable for that alternative, together with its minimal siting impacts and lower relative cost, storage tanks and RTBs were not evaluated further for BB-026.

For Outfalls NC-077, NC-083 and NC-015, the areas required to provide 25, 50, 75 or 100 percent control with storage tanks are presented in Table 8-6. Conceptual alternatives were developed for storage tanks to provide 50 percent CSO control at each of these three outfalls. As described further below, the 50 percent storage tanks would have sufficient volume to provide disinfection for flows up to the 100 percent control level. Based on this finding, no further individual storage or RTB alternatives were evaluated. Specific sites for the conceptual 50 percent storage tank alternatives were not identified, as these alternatives were considered place-holders for comparison to the alternatives that addressed all three outfalls as a consolidated project. The consolidated alternatives include storage tunnels, and consolidation of the outfalls with conveyance to an RTB located adjacent to the Newtown Creek WWTP.

Table 8-6. Outfalls NC-015, NC-083 and NC-077

Level of Control	Area Required for Storage Tank (acres)		
	NC-077	NC-083	NC-015
25%	1.5	1.5	1.9
50%	2.4	2.6	3.6
62.5%	3.1	3.4	4.5
75%	3.7	4.1	5.3
100%	6.8	7.9	9.3

Each of the Retention/Treatment Alternatives described below requires dewatering of stored CSO volumes after wet-weather events occur. Table 8-7 provides a summary of the total storage volume and the associated dewatering rate assuming a 24-hour dewatering period for storage facilities providing 25, 50, 75 and 100 percent levels of CSO control for Outfalls NC-077, NC-083 and NC-015. The 100 percent control level also assumes inclusion of Outfall BB-026.

Table 8-7. Storage and Dewatering System Capacity for Storage Alternatives for Outfalls NC-015, NC-083 and NC-077

Level of Control	Storage Volume (MG)	Dewatering PS Capacity(1) (MGD)
25%	10	10
50%	28	28
62.5%	39	39
75%	54	54
100%	138(2)	138(2)

Notes:
(1) Assumes pump-back of stored CSO within a 24 hour period.
(2) 100% control including BB-026.

The available dry-weather treatment capacity at the Newtown Creek WWTP limits the maximum dewatering rates at which storage facilities can be drained after each storm. The average dry-weather flow at the Newtown Creek WWTP under baseline conditions is 227 MGD, and the dry-weather flow capacity is 310 MGD, which leaves an average of 83 MGD available for dewatering during dry-weather. However, the Newtown Creek WWTP is a high-rate, step-feed plant with no primary settling tanks. As such, due to concerns related to solids loading on the WWTP, a 40-MGD tunnel dewatering rate was determined to be an appropriate dewatering rate limit for the WWTP. . Thus, for the 75 and 100 percent storage alternatives, additional treatment capacity would be needed to maintain a 24-hour dewatering time.

The following concepts were evaluated for control of CSO from Outfalls NC-077, NC-083 and NC-015: consolidation conduit with an RTB; individual off-line storage tanks; and storage tunnels. Additionally, a 100 percent control storage tunnel that also captures CSO from Outfall BB-026 was also evaluated. Discussion relating to these alternatives follows.

Alternative RTB-1: 152 MGD RTB and Consolidation Conduit for Outfalls NC-015, NC-083 and NC-077.

This concept would include a consolidation conduit and a single RTB to provide treatment and disinfection of CSO discharges to Newtown Creek from Outfalls NC-015, NC-083 and NC-077. The facility would be located in the vicinity of the Newtown Creek WWTP. Using a 4,000 gal/day/sf surface overflow rate, an RTB facility with a design flow of 152 MGD could be accommodated on a 3.5-acre site. That design flow rate would provide 50 percent control of bacteria during the recreational season (May 1st through October 31st), and 39 percent control of the annual bacteria load to Newtown Creek. The annual percent control assumes disinfection is applied during the recreational season (May 1st through October 31st), and the tank is operated as a storage facility without disinfection during the non-recreational season (November 1st through April 30th). The layout of Alternative RTB-1 is shown in Figure 8-12.

Flows entering the facility would be screened of large solids and floatable material. Following a wet-weather event, the tank would be dewatered and cleaned. Flushing gates or tipping buckets would be provided to facilitate cleaning of the tank bottom. Flushed grit and solids would be conveyed in a channel to a wet well containing dewatering pumps for pump down of the facilities to the Newtown Creek WWTP.

Disinfection would be accomplished by dosing sodium hypochlorite just upstream of the tank and dechlorination at the outfall, prior to release to the receiving waters. The operation of the chlorination/dechlorination process would be informed by the recent Spring Creek Facility chlorination study, seeking to maximize the efficiency of the bacteria reduction while minimizing the residual chlorination compounds released to the environment in the form of TRC.

A headworks building would be constructed to house screening facilities, pumps, odor control and equipment and piping for chemical delivery, storage, and feed. Ancillary electrical, instrumentation controls and heating, ventilation and air conditioning (HVAC) systems would also be included. With this concept, the facility would be made integral to the RTB tank.

Diversion structures would be required at each of the three outfalls being captured. It is assumed that the consolidation conduit would be constructed by microtunneling, to reduce impacts during construction.

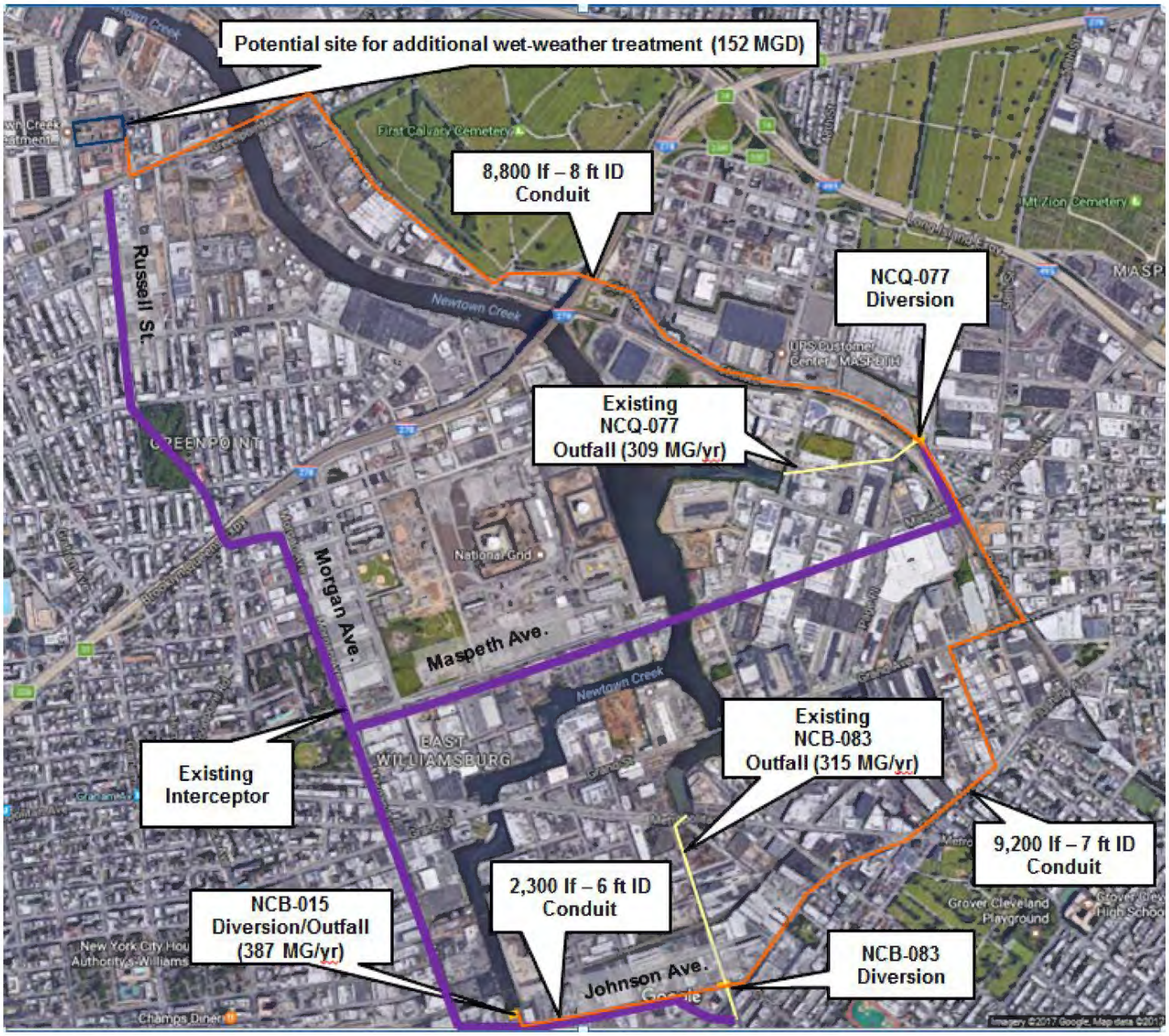


Figure 8-12. Layout of Alternative RTB-1 – Retention Treatment Basin with Consolidation Conduit for Outfalls NC-015, NC-083 and NC-077

The benefits, costs and challenges associated with construction and operation of the RTB are as follows:

Benefits

This alternative would provide 50 percent control of the CSO loads at Outfalls NC-015, NC-083 and NC-077 in the upstream reaches of Newtown Creek during the recreational season (May 1st through October 31st), and provide additional volume reduction and floatables control during the non-recreational season (November 1st through April 30th). Locating the RTB adjacent to the Newtown Creek WWTP would facilitate access for O&M of the facility, and allow for direct discharge of the dewatered solids load to the WWTP.

Cost

The estimated NPW for this control measure is $595M. Details of the estimate are presented in Section 8.4.

Challenges

The challenges associated with this alternative include:

- Permitting and approvals would be necessary for construction of a new outfall for the treated effluent to Newtown Creek. The construction of the outfall diversions and consolidation conduit would require approval of construction within road rights-of-way to be coordinated with the Department of Transportation (DOT).
- Although the 9,800 LF consolidation conduit would be constructed by microtunneling, traffic impacts and utility conflicts would still be anticipated at the multiple microtunneling shafts that would be required along the route.
- While the RTB could theoretically be upgraded in the future to provide chemically-enhanced primary treatment for higher levels of solids reduction, the flexibility to provide higher levels of CSO control would be limited by the contact time available in the tank and the conveyance capacity of the consolidation conduit.
- The discharge from the RTB, while treated, would still be in the downstream reach of Newtown Creek, where recreational use of the waterway is more likely to occur.

Although construction of Alternative RTB-1 would provide 50 percent recreational season (May 1^{st} through October 31^{st}) control of the three major upstream CSOs, this alternative has limited opportunity for future expansion for additional levels of control, carries the potential for significant construction impacts along the near-surface consolidation conduit route, and does not offer significant cost savings over other alternatives that would provide a similar level of control. For these reasons, this alternative was not carried forward to the next level of evaluation for inclusion in the retained alternatives.

Alternative IT-1: Individual Off-line Storage Tanks

As noted earlier, in consideration of siting constraints, a review of developed properties that could be acquired through the eminent domain process was conducted. Although this process of land acquisition is highly undesirable, it was necessary to consider this option to develop traditional individual off-line storage tank options for comparison to other broader CSO control alternatives. The developed parcels within a half-mile radius of the regulators associated with Outfalls NC-015, NC-083 and NC-077 were identified and, based on their size, categorized according to the level of CSO control that could be implemented within their property limits. Cemeteries, schoolyards, parks and parcels associated with transportation uses were excluded from the analysis. As an example, Figure 8-13 summarizes the analyses for Outfall NC-083. The area in acres is shown for each highlighted parcel. Parcels highlighted in blue, green and orange would be large enough to accommodate 25, 50 or 75 percent CSO control storage tanks, respectively. It should be stressed that none of the highlighted sites are specifically being considered for a storage tank facility. The intent is to demonstrate the lack of suitable sites and the difficulties in site acquisition that would be encountered if this alternative were to be further pursued. Similar analyses were conducted for Outfalls NC-077 and NC-015. It is noted that no single developed parcel that could accommodate 100 percent CSO control storage tanks were identified within the search radius for Outfalls NC-083 and NC-015.

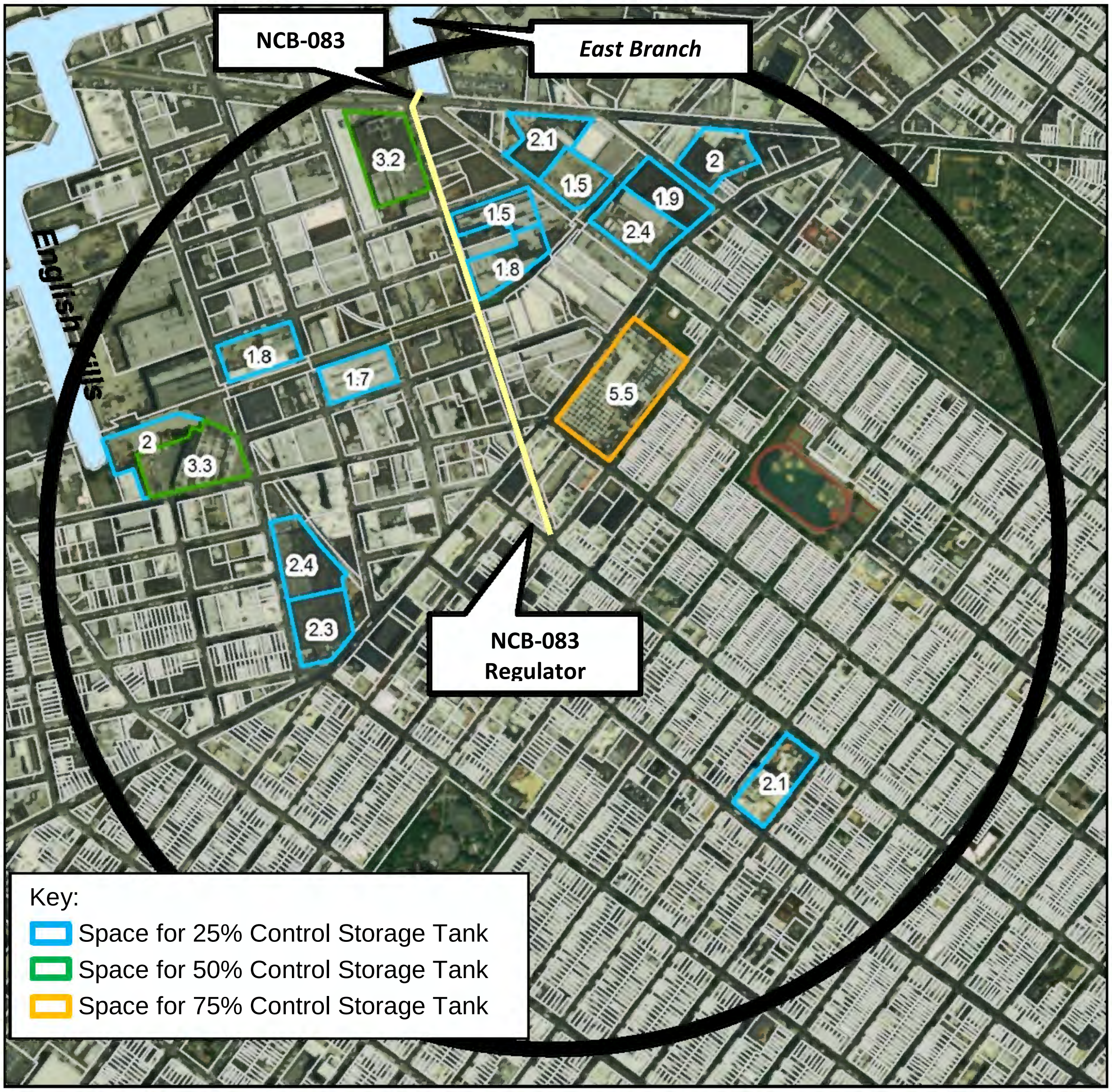


Figure 8-13. Developed Parcels Larger than 1.5 Acres Identified within Half-mile Radius from the Nicholas Weir/Regulator (Outfall NC-083)

Table 8-8 summarizes the individual storage tank dimensions and characteristics associated with the various levels of CSO control. Due to the multiple developed parcels that could accommodate a given tank size, approximate lengths of the corresponding conveyance elements had to be assumed for most tanks for cost estimation purposes.

For each facility, a diversion chamber would need to be constructed along each outfall to divert overflows to the storage tanks. The diameters of each collection conduit and dewatering force main are shown in Table 8-8.

Table 8-8. Characteristics of CSO Retention Tanks for Outfalls NC-077, NC-083 and NC-015

Outfall	Level of Control	Tank Volume (MG)	Inside Length (ft)	Inside Width (ft)	Dewatering PS Capacity (MGD)	Collection Conduit Diameter (ft)	Dewatering Force Main Diameter (ft)
NC-077	25%	2.4	146	73	2.4	3.0	1.0
	50%	6.8	248	124	6.9	4.5	2.0
	75%	14.2	356	178	14.2	5.5	2.0
	100%	37	574	287	37	2 X 8	4.0
NC-083	25%	3	164	82	3	3.5	1.0
	50%	8.5	275	138	8.5	5	2.0
	75%	17.2	392	196	17.2	7.5	3.0
	100%	41.1	605	303	41.1	2 x 8	4.0
NC-015	25%	4.3	196	98	4.3	4.0	2.0
	50%	12.3	332	166	12.3	5.5	2.0
	75%	22	443	221	22	7.0	3.0
	100%	44.3	628	315	44.3	2 x 8	4.0

Flows entering the facilities would be screened of large solids and floatable material. Following the event, the tank would be dewatered and cleaned and made ready for the next event. Flushing gates or tipping buckets would be provided to facilitate cleaning of the tank bottom. Flushed grit and solids would be conveyed in a channel to a wet well containing dewatering pumps for pump down of the facilities to the Newtown Creek WWTP. Ventilation of the tanks with activated carbon odor control facilities would be provided.

Given the large tank volumes shown in Table 8-8 an evaluation was conducted to determine the maximum flow rate for disinfection that could be achieved with those volumes assuming a 15 minute contact time, and the associated level of seasonal bacteria load control. The results indicated that, for Outfalls NC-077, NC-083 and NC-015, the chlorination rates that could be implemented for the 50 percent annual control tanks would exceed the rates required to provide 100 percent recreational season (May 1st through October 31st) bacteria load control. This analysis is summarized in Table 8-9 below.

Table 8-9. Potential Peak Disinfection Capacity for 50 Percent Control Storage Volume

Outfall	Tank Volume (MG)	Peak Disinfection Capacity (MGD)	Maximum Peak Flow During Recreational Season(1) (MGD)
NC-077	6.8	653	481
NC-083	8.5	816	725
NC-015	12.4	1190	564

Note:

(1) Recreational Season is from May 1st through October 31st.

Providing 75 or 100 percent recreational season control would be more cost-effectively achieved through adding disinfection to the 50 percent annual control tanks than by building larger tanks, and would avoid the additional site acquisition issues associated with the greater area requirements of the larger tanks. For these reasons, the 75 and 100 percent control storage tanks were not retained for further consideration.

The benefits, costs and challenges associated with construction and operation of the individual CSO storage tanks are as follows:

Benefits

The primary benefit of a storage tank is its predicted high degree of volumetric CSO and annual bacterial capture. The operations are simple in comparison to treatment facilities and DEP operations staff is familiar with the maintenance requirements of the equipment used in this type of facility. In addition, the surface of the tanks could be designed to provide secondary uses, such as a parking lot, ball fields, a gathering area, a park or other recreational amenities.

Cost

The estimated NPW for this control measure at Outfalls NC-015, NC-083 and NC-077 ranges from $627M to $901M for 25 percent annual control and 50 percent annual control, respectively. Details of these estimates are presented in Section 8.4.

Challenges

The challenges associated with this alternative include:

- Acquisition of the sites would likely require either a negotiated acquisition process or eminent domain. In addition, most of the area covered by the siting assessment for Outfalls NC-077, NC-083 and NC-015 are designated by the City as NYC Industrial Business Zones (IBZ). These areas were established to protect existing manufacturing districts and encourage industrial growth citywide, and include tax credits for industrial and manufacturing firms choosing to relocate to these zones. Displacing active industrial or manufacturing uses in this area would run counter to the concept of the IBZ.

- During construction, plans for maintenance and protection of traffic will be required, along with coordination of construction methods and schedules with DOT. These issues will need to be addressed not only for the tank site, but for the alignments of the dewatering force main and the outfall sewer diversion and conveyance to the tanks. As a result, the immediate and long-term neighborhood impacts are expected to be widespread and will impact a large area of the community.

- Past operational experience of off-line CSO storage tanks in other parts of NYC indicates that grit and solids in the pump-back following a wet-weather event have a tendency to drop out of suspension in the interceptor. The deposition of sediment reduces interceptor capacity and increases the risk of flooding and sewer back-ups. More frequent cleaning of the interceptors would be necessary to manage this issue.

- Control of the three CSO outfalls would require operation and maintenance of three separate facilities remote from the Newtown Creek WWTP.

Alternatives DT-1 through DT-4 – Tunnel Storage for Outfalls NC-015, NC-083 and NC-077

As a result of the general limited availability of suitable sites for traditional storage and treatment technologies within the Newtown Creek watershed, tunnel alternatives were developed further. Unlike traditional tanks, tunnels:

1) Can provide for both conveyance and storage of CSO;

2) Require less permanent above-ground property per equivalent unit of storage volume;

3) Minimize surface construction impacts;

4) Reduce construction related groundwater pumping and treatment costs; and

5) Reduce the volume of near-surface spoil material to be treated, handled and transported for disposal during construction. For the Newtown Creek watershed, the likelihood of encountering contaminated near-surface soils is high.

These benefits make tunnel storage more practical for highly developed watersheds such as Newtown Creek. Tunnel alternatives are described below.

Tunnel construction would involve the boring of a linear storage conduit underground using a tunnel boring machine (TBM). Shafts would be installed during construction for the connection of CSO diversion pipes and O&M access. A tunnel dewatering pumping station (TDPS) would also be included at the downstream end of the tunnel with pumped discharges being conveyed to the Newtown Creek WWTP for treatment after wet-weather events. A mechanical ventilation system would be provided with an activated carbon odor control system. Additional passive odor control systems and/or backdraft dampers would be provided at the drop shafts.

Potential sites for the mining shaft/TDPS were identified. Figure 8-14 shows one potential site within the boundaries of the WWTP. Figure 8-15 shows a potential site currently owned by the DEP adjacent to Outfall NC-077. The site within the Newtown Creek WWTP was not considered advantageous due to considerations for reserving that site for potential future upgrades of the Newtown Creek WWTP, but other sites in the vicinity of the Newtown Creek WWTP could be considered as part of more detailed siting investigations. The deep tunnel alignments evaluated for the Newtown Creek watershed would either begin at a site near the Newtown Creek WWTP (longer tunnel) or at the DEP owned parcel near Outfall NC-077 (shorter tunnel). These parcels will be abbreviated herewith as “WWTP” and “DEP” parcels, respectively. The tunnels would terminate at the LIRR owned parcel near Outfall NC-015. For both mining shaft site options, the alignments would run either under Newtown Creek, to the extent possible, or under the public ROW, to the extent possible. As such, four potential tunnel alignments were identified and are shown in Figures 8-16 and 8-17, for the shorter and longer tunnel options, respectively. A longer tunnel option for 25 percent CSO control was not evaluated because the diameter associated with 25 percent control for the long tunnel would have been too small to be practical for a deep tunnel. Therefore, for this level of control, only the shorter tunnel with TDPS at the DEP parcel was evaluated further. Additionally, a shorter tunnel for the 100 percent level of control was not considered further as it resulted in a large diameter that was at the limit of current TBM technology.

Figure 8-14. Potential Mining Shaft Site near the Newtown Creek WWTP

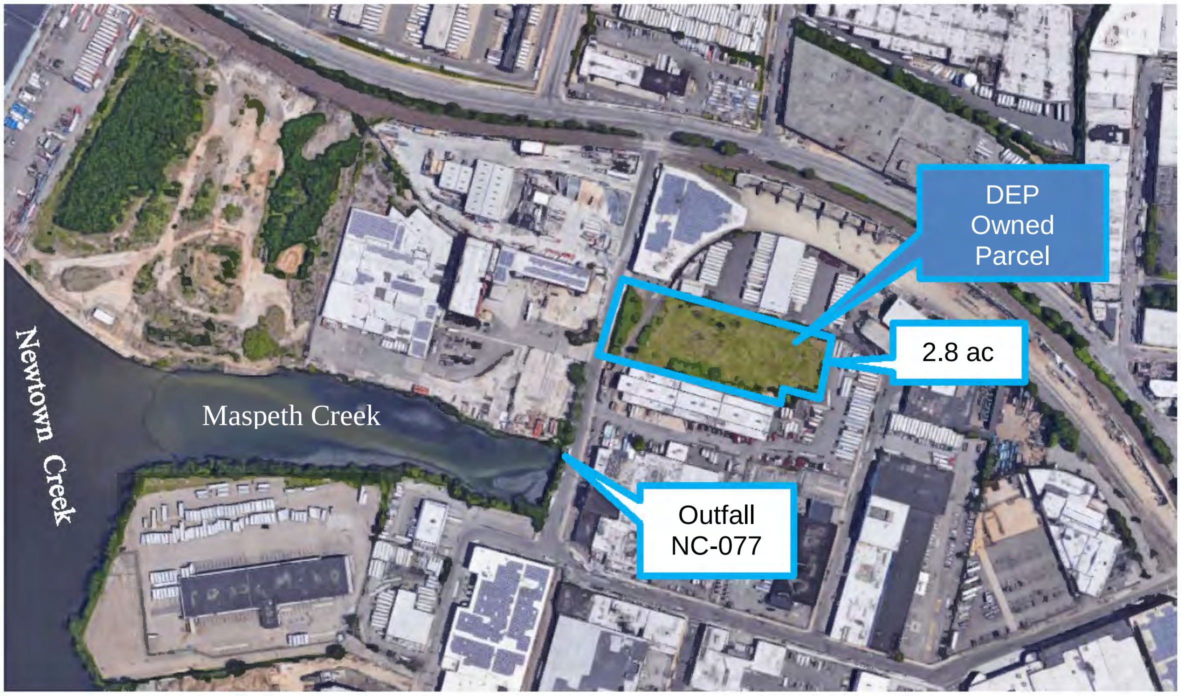


Figure 8-15. Potential Shaft Site at DEP Owned Parcel

Several conceptual layouts were evaluated for the tunnel alternatives. These conceptual layouts and sites were developed for the purposes of developing costs and evaluating the feasibility of the various CSO storage tunnel alternatives. The final siting of the dewatering pumping station, the tunnel alignment and other associated details of the tunnel alternatives presented herein will be further evaluated and finalized during subsequent planning and design stages.

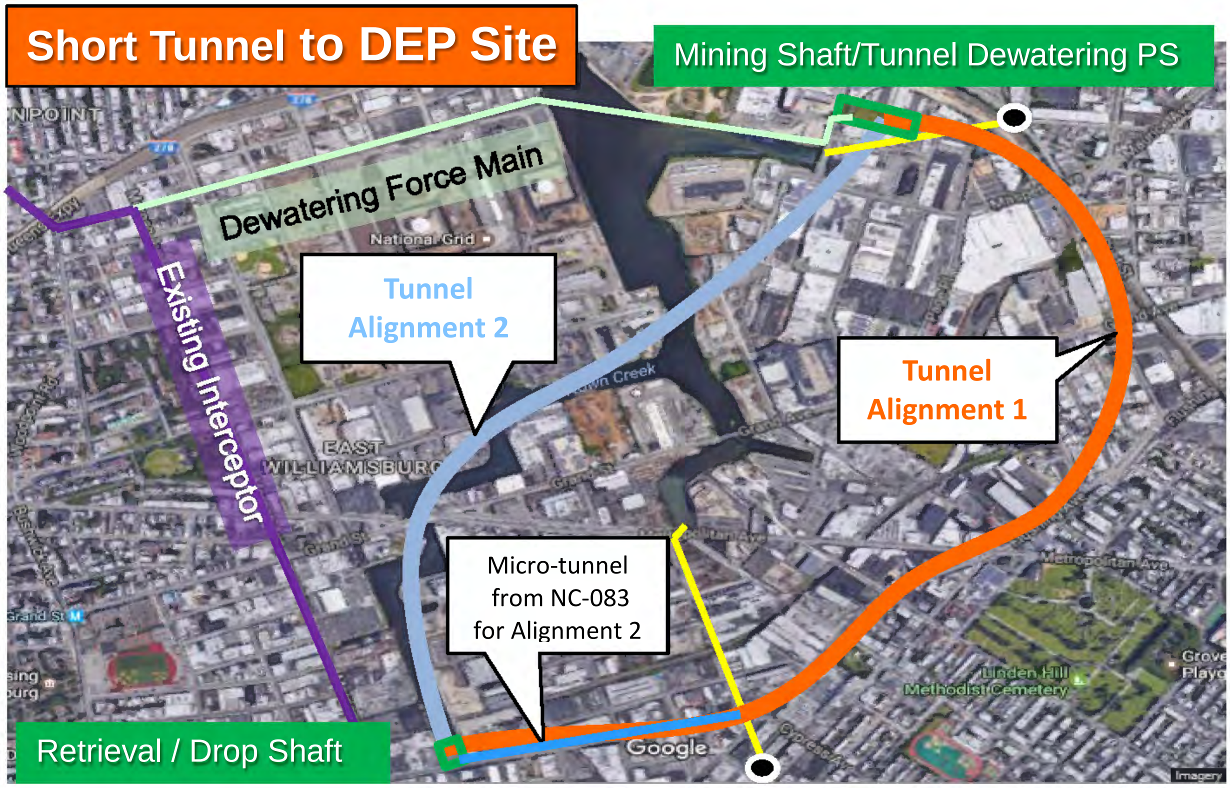


Figure 8-16. Conceptual Layout of Tunnel Storage with TDPS at DEP Parcel –Tunnel Alignments 1 and 2 for 25, 50, 62.5 and 75 Percent CSO Control of Outfalls NC-015, NC-083 and NC-077

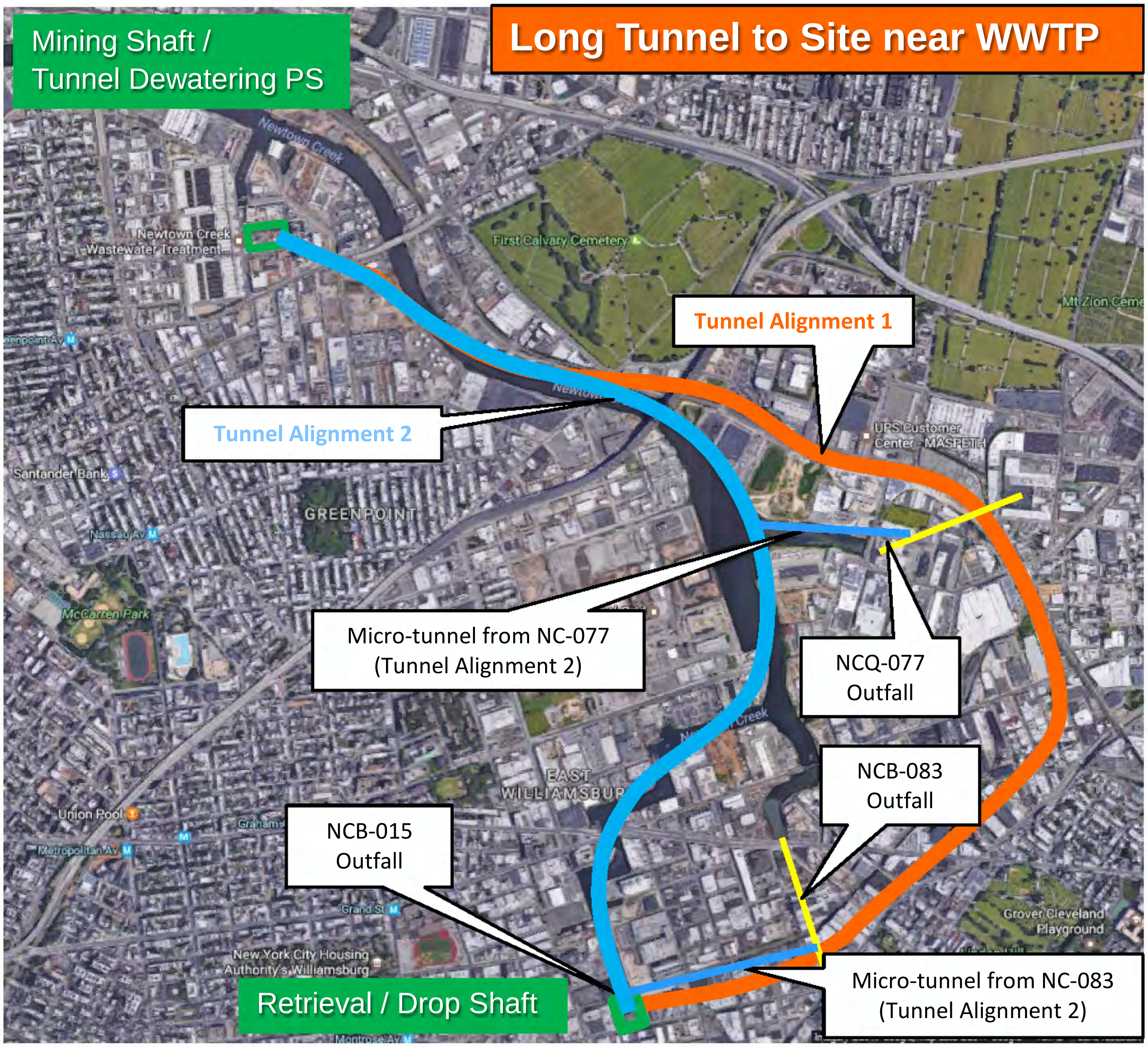


Figure 8-17. Conceptual Layout of Tunnel Storage with TDPS near WWTP for 50, 62.5 and 75 Percent CSO Control of Outfalls NC-015, NC-083 and NC-077 and 100 Percent CSO Control of Outfalls BB-026, NC-015, NC-083 and NC-077

Using the IW model, an evaluation was performed that included several iterations to assess the tunnel sizes necessary to provide the storage volume required for 25, 50, 62.5 and 75 percent control for the three largest outfalls, and 100 percent control for all four of the largest outfalls. The storage volumes and dewatering rates provided in Table 8-7 were used as a basis for sizing the tunnels. Required tunnel diameters were rounded up to the nearest foot, and it was assumed that the diameter would be constant for the entire length of the tunnel.

Based on available geotechnical information, which included United States Geological Survey rock contours and boring information from DEP water tunnels that run through the area, the depth to bedrock in the project area varies from approximately 60 feet in the vicinity of the proposed mining shaft at the WWTP site to approximately 230 feet in the vicinity of the proposed retrieval shaft at Outfall NC-015. As risk significantly increases with variable ground conditions, it is generally desirable to maintain a tunnel profile either completely within soft ground or completely in hard rock. Given the lengths of the tunnel routes and the density of development in the Newtown Creek area, passing under multiple private property parcels was unavoidable for the tunnel routes. This would necessitate acquisition of either the parcel or an easement on the parcel through either negotiated acquisition eminent domain. Although a rock tunnel would have deeper shafts than a soft ground tunnel, the unit costs of tunneling in rock are typically lower than the unit cost for similarly sized soft ground tunneling. Based upon these considerations, a vertical tunnel alignment in rock was considered to have lower risks and costs than a soft ground/mixed face tunnel vertical alignment for the storage tunnels being considered for this LTCP, and the alignments presented herein are based on a rock alignment.

Two DEP water tunnels run through the Newtown Creek project area. However, these tunnels are in the range of 500-to-600-feet deep, and would be well below the vertical alignment of the CSO storage tunnel. The water tunnels are not anticipated to be affected by the CSO storage tunnel, but the presence of the water tunnels would be taken into account during design.

Each of the tunnel alternatives requires a dewatering pumping station to convey the retained CSO volumes to the treatment plant following a wet-weather event. The capacities of the dewatering pumping stations for each of the tunnel alignment/level of control alternatives are shown in Table 8-10. The dewatering pumping station capacities shown are based on a 24 hour dewatering period. Analyses of the conveyance capacity of the interceptor system near the TDPSs revealed that for the short tunnel options, with the TDPS at the DEP parcel, the local Maspeth Avenue Interceptor did not have sufficient capacity for the dewatering flows from the 25 percent control tunnel or larger. The closest location with sufficient capacity would be downstream of the junction between the Maspeth Avenue and Morgan Avenue interceptors, about 5,800 ft away and across Newtown Creek from the TDPS site. A dewatering force main to that location has been included for those alternatives. For the 75 and 100 percent CSO control alternatives, the capacities indicated in Table 8-10 for 24-hour dewatering would exceed the level that would be considered prudent from a loading perspective and to maintain treatment levels at the Newtown Creek WWTP. Thus to consider a 75 or 100 percent CSO control alternative would require construction of an additional treatment facility. As noted above, the maximum dewatering rate based on the considerations of loading impacts to the WWTP would be 40 MGD.

Table 8-10. Tunnel Characteristics and Dewatering Pumping Station Capacity of Based on 24-hour Dewatering

Alternative/Level of CSO Control	Required Storage Volume (MG)	Tunnel Length (ft)	Selected Tunnel Diameter (ft)	Storage Volume Provided (MG)	PS Capacity (MGD)
DT-1a/25% (DEP/In-Creek)	10	7,570	16	11	11
DT-1b/25% (DEP/ROW)	10	9,980	16(1)	15	15
DT-2a/50% (WWTP/In-Creek)	28	13,700	19	28	28
DT-2b/50% (WWTP/ROW)	28	18,800	16	28	28
DT-2c/50% (DEP/In-Creek)	28	7,570	26	29	29
DT-2d/50% (DEP/ROW)	28	9,980	23	30	30
DT-3a/62.5% (WWTP/In-Creek)	39	13,700	22	39	39
DT-3b/62.5% (WWTP/ROW)	39	18,800	19	39	39
DT-3c/62.5% (DEP/In-Creek)	39	7,570	30	39	39
DT-3d/62.5% (DEP/ROW)	39	9,980	26	39	39
DT-4a/75% (WWTP/In-Creek)	54	13,700	26	55	55(3)
DT-4b/75% (WWTP/ROW)	54	18,800	23	58	58(3)
DT-4c/75% (DEP/In-Creek)	54	7,570	36	56	56(3)
DT-4d/75% (DEP/ROW)	54	9,980	32	59	59(3)
DT-5a/100% (WWTP/In-Creek)(2)	138	13,700	42	137(3)	137(3)
DT-5b/100% (WWTP/ROW)(2)	138	18,800	36	143(3)	143(3)

Notes:

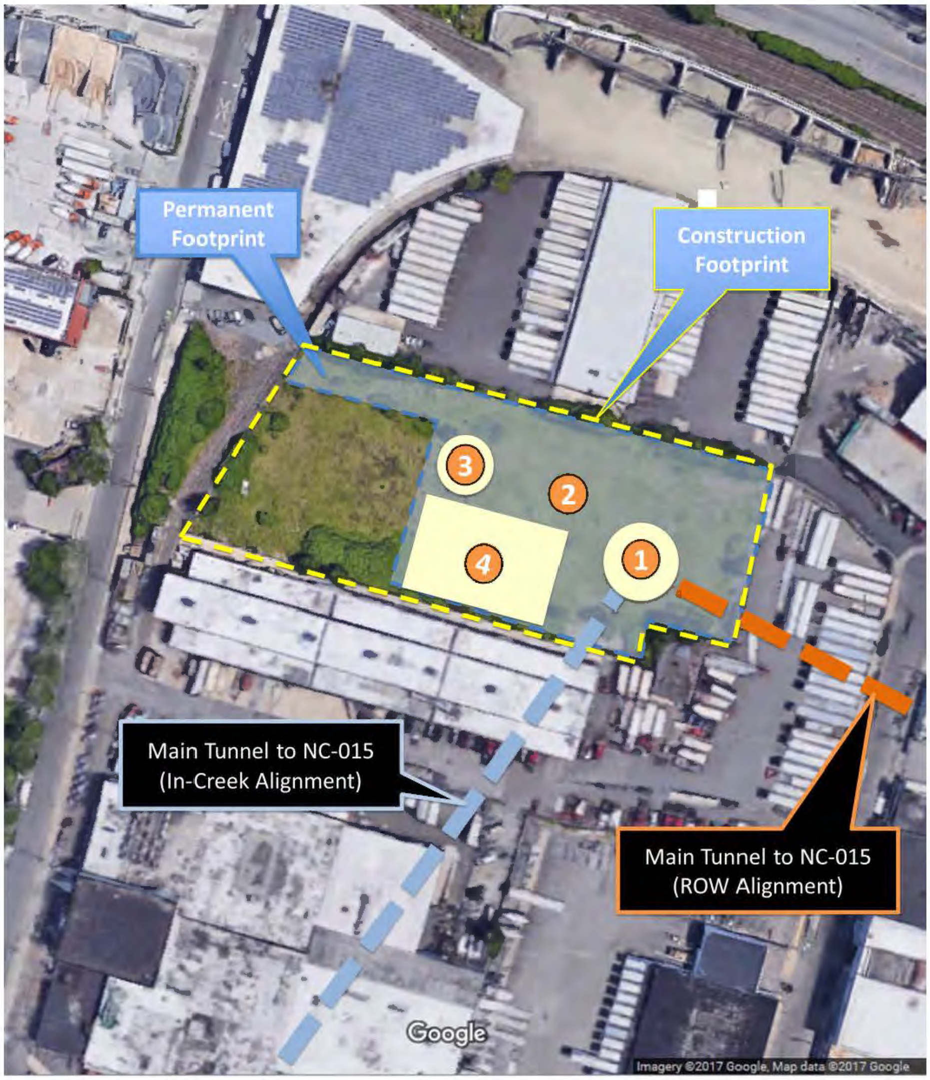
(1) Assumed minimum cost-effective diameter for TBM technology.
(2) 100% control of Outfalls BB-026, NC-077, NC-083 and NC-015.
(3) Maximum capacity based on loadings to the Newtown Creek WWTP would be 40 MGD.

Alternative DT-1 – 25 Percent CSO Control Tunnel Options for Outfalls NC-015, NC-083 and NC-077, Mine from DEP Site

The tunnels designated as Alternatives DT-1a and DT-1b in Table 8-11 would provide 25 percent CSO control with the tunnel launching shaft and dewatering pumping station located at the DEP parcel near Outfall NC-077. From this mining shaft/TDPS site, the tunnel alignments would either follow the Creek alignment or the ROW alignment as shown in Figure 8-15. In both cases, the tunnel internal diameter would be 16 ft. A smaller diameter would provide 25 percent CSO control for the shorter ROW alignment (Alternative DT-1b). However, a rock tunnel at less than 16 ft diameter would be less efficient to construct due to space constraints, and would not likely provide cost savings compared to a 16-ft diameter tunnel. Upon completion of the tunnel, the associated TDPS would be constructed. The TDPS could either be a cavern pumping station constructed in rock, or a circular design for which a dedicated shaft would be provided. To minimize the extent of surface features, a cavern pumping station was assumed for the LTCP. The TDPS capacities would be 11 MGD and 15 MGD for Alternatives DT-1a and DT-1b, respectively. The layout of the pumping station and appurtenant features assuming a cavern configuration is shown on Figure 8-18.

Upon completion of the tunnel mining operations, the mining shaft would be converted to a screenings and grit removal shaft. A grit sump would be constructed in the bottom of the shaft, coarse bar screen would be provided on the downstream side of the grit sump, and an overhead bridge crane would be provided with clamshell bucket and bar screen rake attachments for removal of grit, screenings, or other large objects captured in the sump. Two access shafts would be provided for the pumping station: one main access shaft, and one equipment access shaft. An above-ground building housing HVAC and electrical support equipment for the pumping station would be provided adjacent to the access shafts.

Both the ROW and the Creek tunnel alignments would include diversion structures with weirs and tide gates on the existing NC-015, NC-083 and NC-077 outfalls, and both alignments would require drop shafts at Outfalls NC-015 and NC-077. For the Creek alignment, a micro-tunneled connection would be provided from the NC-083 diversion structure to the drop shaft at NC-015. For the ROW alignment, a drop shaft for NC-083 flows would be located adjacent to that outfall, in proximity to where the tunnel alignment crosses under the outfall. The drop shafts would include influent trash racks/grit sumps and passive odor control if determined to be necessary during design. Figure 8-19 shows the proposed configurations in the vicinity of Outfalls NC-015 and NC-083, and Figure 8-20 shows the configurations in the vicinity of Outfall NC-077. Table 8-10 above summarizes the key capacities and dimensions of Alternatives DT-1a and DT-1b.



1	Mining Shaft/Screen & Grit Removal Shaft
2	PS Equipment Access Shaft
3	PS Main Access Shaft
4	Pump Station Building

Figure 8-18. Conceptual Layout of Mining Shaft/TDPS at DEP Owned Parcel – Shorter Tunnel

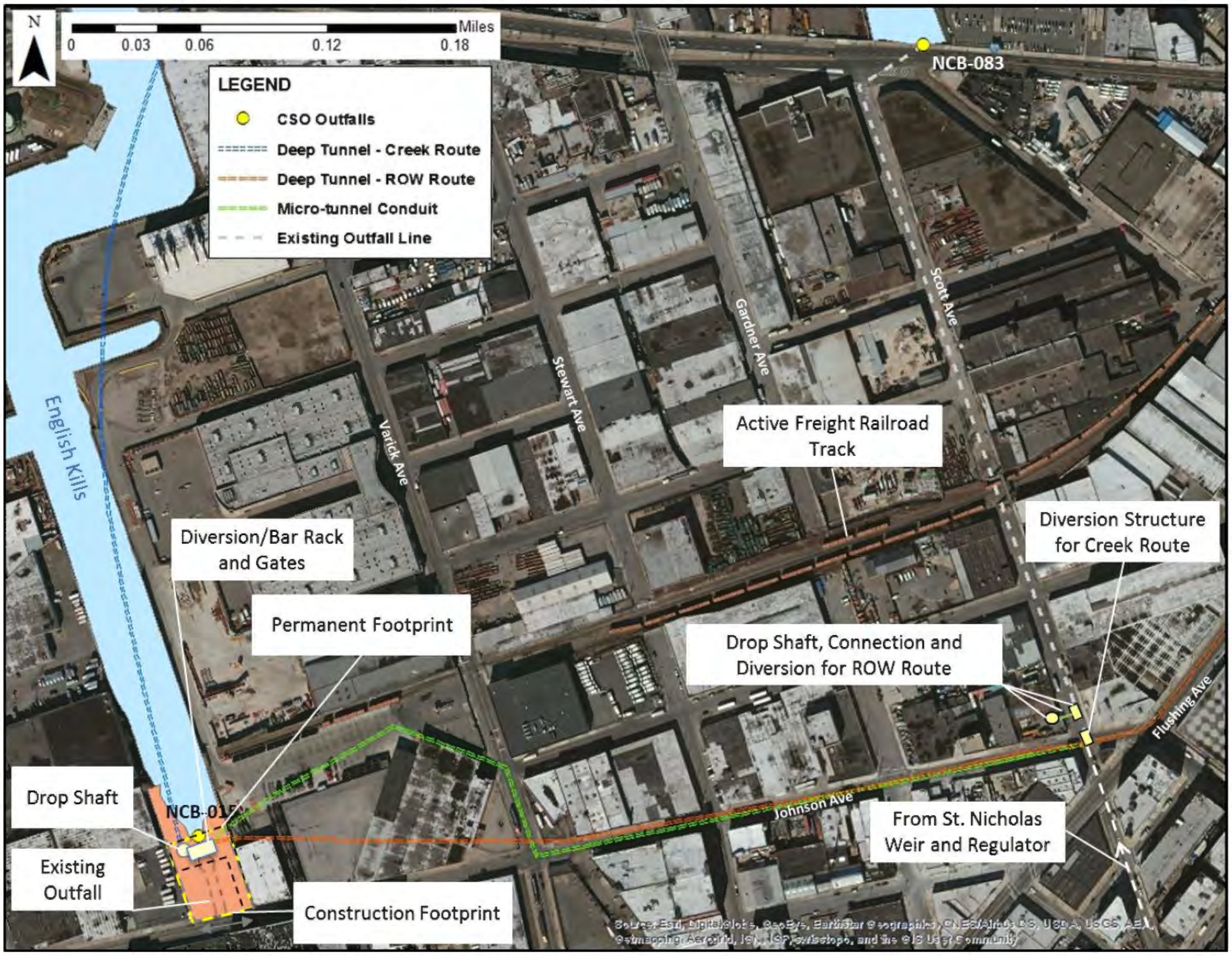


Figure 8-19 Details of Diversion Structures/Drop Shafts for Outfalls NC-083 and NC-015

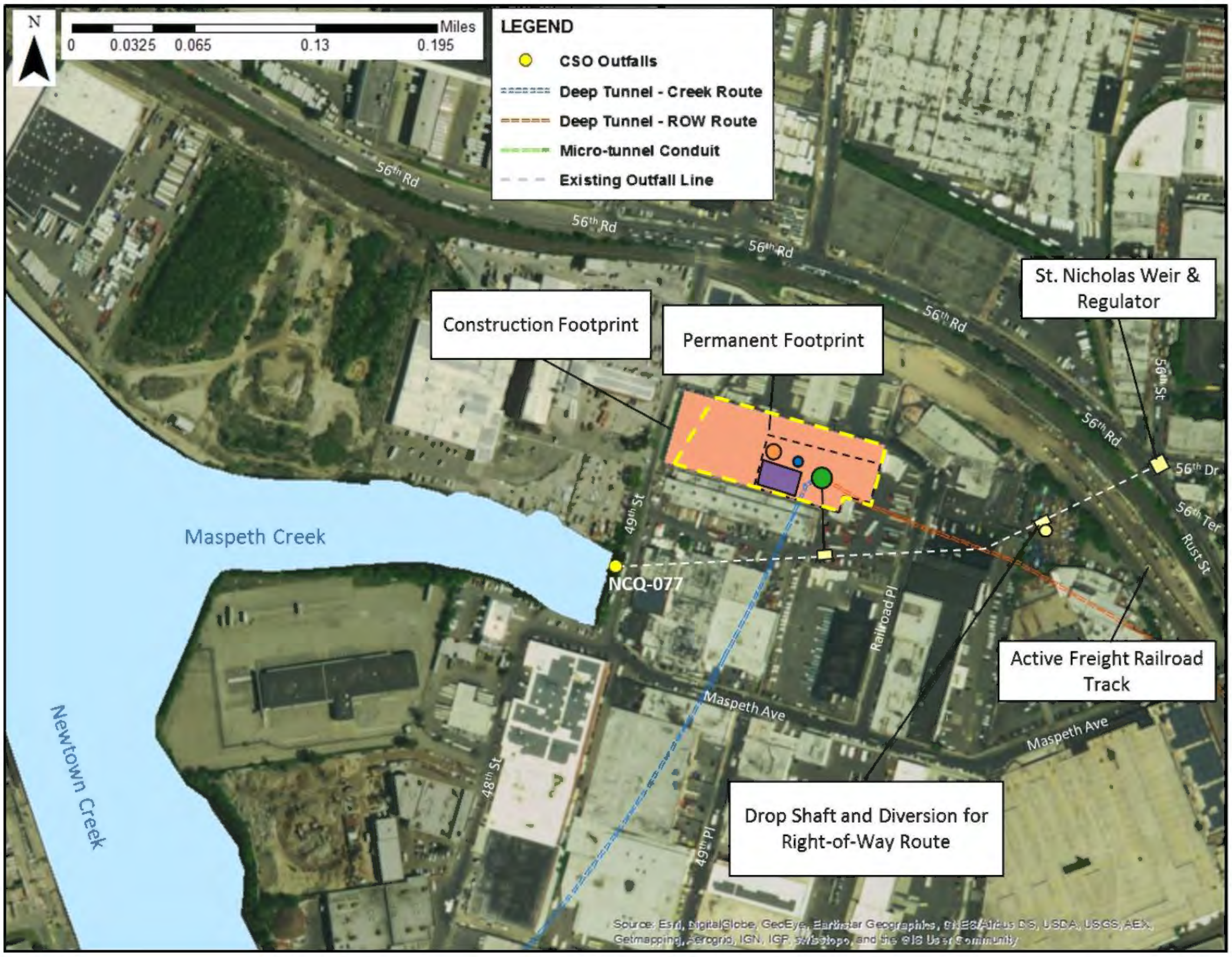


Figure 8-20 Details of Diversion Structures/Drop Shafts for Outfalls NC-077 (Shorter Tunnel)

The benefits, costs and challenges associated with this tunnel storage alternative are as follows:

Benefits

The primary benefit of tunnel storage is the high level of CSO volume reduction with minimal permanent above-ground land requirements and disruption during construction. The single tunnel facility addresses three of the largest CSO discharge locations to Newtown Creek.

Cost

The estimated NPW for this control measure is $437M for Alternative DT-1a (DEP site/creek route) and $456M for Alternative DT-1b (DEP site/ROW route). Details of the estimates are presented in Section 8.4.

Challenges

The challenges associated with this alternative include:

- Uncertainty related to the availability of the DEP site due to competing needs for existing maintenance needs and future treatment requirements for use as a tunnel mining location and long-term location for the TDPS.
- Construction of the long tunnel dewatering force main across Newtown Creek.
- Construction of the micro-tunneled connection from NC-083 to the drop shaft at NC-015 for the Creek route.
- Potential impacts of the dewatered flow on sediment deposition in the Morgan Avenue interceptor downstream of the dewatering force main tie-in location.
- More difficult/complex O&M associated with the deep dewatering force main and deep grit/screenings shaft.
- The potential for sediment deposition in the tunnel.
- The potential for hydraulic surge conditions in the tunnel.
- The potential for encountering unforeseen geotechnical conditions during construction of the tunnel, shafts, or cavern TDPS.
- Maintaining outfall functionality during construction of the diversion structures.
- Limited space for construction of the drop shaft at NC-015.
- Property acquisition through either negotiated acquisition or eminent domain process.

Both Alternatives DT-1a and DT-1b were carried forward to the next level of evaluation for inclusion in the basin-wide alternatives.

Alternative DT-2 – 50 Percent CSO Control Tunnel for Outfalls NC-015, NC-083 and NC-077

The tunnels designated as Alternatives DT-2a, DT-2b, DT-2c and DT-2d would provide 50 percent CSO control with the tunnel launching shaft and dewatering pumping station to be located at either the DEP parcel near Outfall NC-077 for the shorter tunnel option, or at a site in the vicinity of the Newtown Creek WWTP for the longer tunnel option. For each mining shaft/TDPS site, the tunnel alignments would either follow the Creek alignment or the ROW alignment shown in Figures 8-16 and 8-17 above. The tunnel internal diameters would range from 19 ft to 26 ft, depending on the route. As described for Alternative DT-1, the TDPS was assumed to be a cavern pumping station. The TDPS capacity would range from 28 MGD to 30 MGD, depending on the tunnel route. The layout of the pumping station configuration for the DEP owned parcel, assuming a cavern configuration, is shown above on Figure 8-18. The layout for a site in the vicinity of the Newtown Creek WWTP for the longer tunnel option would be similar. The configurations of the diversion structures and drop shafts for Outfalls NC-015 and NC-083 would be similar to the arrangements shown in Figure 8-19 above for all the potential alignments of this alternative. For the short tunnel from the DEP site, the arrangement at Outfall NC-077 would be similar to the arrangement shown in Figure 8-20. For the long tunnel alignment to the vicinity of the Newtown Creek

WWTP, the arrangement of diversion structures/drop shafts is presented in Figure 8-21. As with Alternative DT-1, the drop shafts would include influent trash racks/grit sumps and passive odor control if

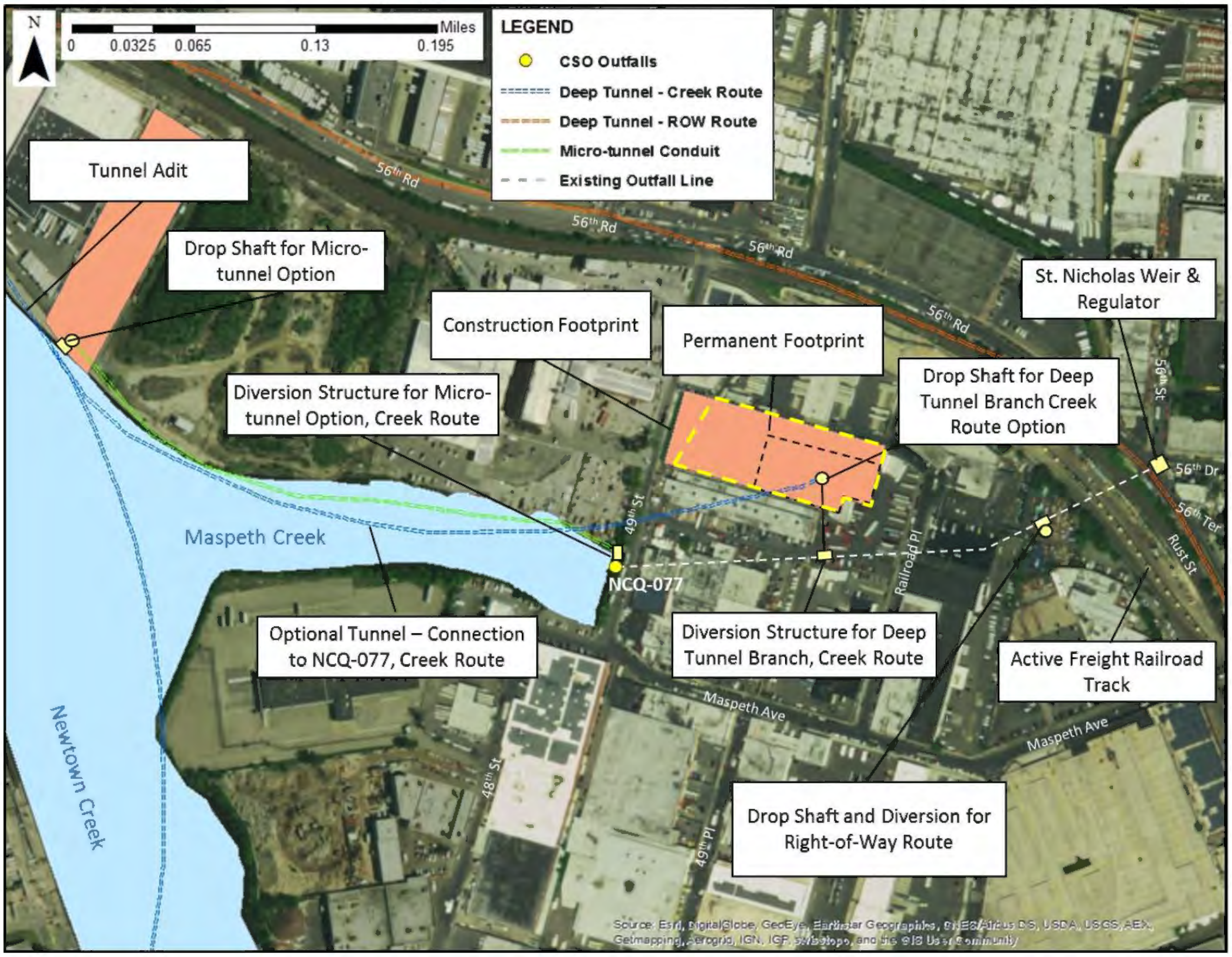


Figure 8-21 Details of Diversion Structures/Drop Shafts for Outfalls NC-077 (Longer Tunnel)

determined to be necessary during design. Table 8-10 above summarizes the features of Alternatives DT-2a, DT-2b, DT-2c and DT-2d.

The benefits, costs and challenges associated with this tunnel storage alternative are as follows:

<u>Benefits</u>

The primary benefit of tunnel storage is the high level of CSO volume reduction with minimal permanent above-ground land requirements and disruption during construction. The single tunnel facility addresses three of the largest CSO discharge locations to Newtown Creek.

Benefits of the long tunnel with TDPS in the vicinity of the Newtown Creek WWTP over the short tunnel with TDPS at the DEP site include that the long dewatering force main from the DEP site would be eliminated, along with the risks of sediment deposition in the Morgan Avenue interceptor from the dewatering flow. This site would also be much closer to the Newtown Creek WWTP, making access to the TDPS easier from the Newtown Creek WWTP.

<u>Cost</u>

The estimated NPW for this control measure is $576M for Alternative DT-2a (WWTP site/Creek route), $571M for Alternative DT-2b (WWTP site/ROW route), $574M for Alternative DT-2c (DEP site/Creek route) and $576M for Alternative DT-2d (DEP site/ROW route). Details of the estimates are presented in Section 8.4.

<u>Challenges</u>

The challenges associated with this alternative would be similar to those identified for Alternative DT-1, with the following differences:

- For the long tunnel route, uncertainty related to the availability of sites in the vicinity of the Newtown Creek WWTP for use as a tunnel mining location and long-term location for the TDPS and any necessary property acquisition through negotiated acquisition or eminent domain.
- Specific challenges associated with dewatering from the DEP site would not apply to a site near the Newtown Creek WWTP. The dewatering force main would be much shorter, and would tie in directly to the Newtown Creek WWTP.

Alternatives DT-2a, DT-2b, DT-2c and DT-2d were carried forward to the next level of evaluation for inclusion in the basin-wide alternatives.

Alternative DT-3 – 62.5 Percent CSO Control Tunnel for Outfalls NC-015, NC-083 and NC-077

The tunnels designated as Alternatives DT-3a, DT-3b, DT-3c and DT-3d would provide 62.5 percent CSO control with the tunnel launching shaft and dewatering pumping station to be located at either the DEP parcel near Outfall NC-077 for the shorter tunnel option, or a site in the vicinity of the Newtown Creek WWTP for the longer tunnel option. For each mining shaft/TDPS site, the tunnel alignments would either follow the Creek alignment or the ROW as shown in Figures 8-16 and 8-17 above. The tunnel internal diameters would range from 19 ft to 30 ft depending on the alignment. Upon completion of the tunnel, a TDPS would be constructed. As described for Alternatives DT-1 and DT-2, the TDPS was assumed to be a cavern pumping station. The dewatering pumping station capacity would have a capacity of 39 MGD for the four tunnel alignment options. The layout of the pumping station configuration for the DEP owned parcel, assuming a cavern configuration, is shown above on Figure 8-18. The layout for a site in the vicinity of the Newtown Creek WWTP for the longer tunnel option would be similar. The configurations of the diversion structures and drop shafts for Outfalls NC-015 and NC-083 would be similar to the arrangements shown in Figure 8-19 above for all the potential alignments of this alternative. For the short tunnel from the DEP site, the arrangement at Outfall NC-077 would be similar to the arrangement shown in Figure 8-20. For the long tunnel alignment to the vicinity of the Newtown Creek WWTP, the arrangement of diversion structures/drop shafts would be as shown in Figure 8-21. As with Alternatives DT-1 and DT-2, the drop shafts would include influent trash racks/grit sumps and passive odor control if determined to be necessary during design. Table 8-10 above summarizes the features of Alternatives DT-a, DT-3b, DT-3c and DT-3d.

The benefits, costs and challenges associated with this tunnel storage alternative are as follows:

Benefits

The primary benefit of tunnel storage is the high level of CSO volume reduction with minimal permanent above-ground land requirements and disruption during construction. The single tunnel facility addresses three of the largest CSO discharge locations to Newtown Creek.

Benefits of the long tunnel with TDPS in the vicinity of the Newtown Creek WWTP over the short tunnel with TDPS at the DEP site include that the long dewatering force main from the DEP site would be eliminated, along with the risks of sediment deposition in the Morgan Avenue interceptor from the dewatering flow. This site would also be much closer to the Newtown Creek WWTP, making access to the TDPS easier from the Newtown Creek WWTP.

Cost

The estimated NPW for this control measure is $646M for Alternative DT-3a (WWTP site/Creek route), $659M for Alternative DT-3b (WWTP site/ROW route), $651M for Alternative DT-3c (DEP site/Creek route) and $632M for Alternative DT-3d (DEP site/ROW route). Details of the estimates are presented in Section 8.4.

Challenges

The challenges associated with these tunnel alternatives would be similar to the challenges identified for the DT-2 alternatives for 50 percent control.

Alternatives DT-3a, DT-3b, DT-3c and DT-3d were carried forward to the next level of evaluation for inclusion in the basin-wide alternatives.

Alternative DT-4 – 75 Percent CSO Control Tunnel for Outfalls NC-015, NC-083 and NC-077

The tunnels designated as Alternatives DT-4a, DT-4b, DT-4c and DT-4d would provide 75 percent CSO control with the tunnel launching shaft and dewatering pumping station to be located at either the DEP parcel near Outfall NC-077 for the shorter tunnel option, or a site in the vicinity of the Newtown Creek WWTP for the longer tunnel option. For each mining shaft/TDPS site, the tunnel alignments would either follow the Creek alignment or the ROW as shown in Figures 8-16 and 8-17 above. The tunnel internal diameters would range from 23 ft to 36 ft depending on the alignment. Upon completion of the tunnel, a TDPS would be constructed. As described for Alternatives DT-1 and DT-2, the TDPS was assumed to be a cavern pumping station. The dewatering pumping station capacity for 24-hour dewatering would range from 55 MGD to 59 MGD, depending on the route. However, based on considerations of loadings to the Newtown Creek WWTP, the maximum dewatering rate would be 40 MGD. To achieve a 24-hour dewatering time, an approximately 20 MGD RTB would be required for treatment of the additional dewatering flow. The 20 MGD RTB would require an approximately 1.0-acre site. The layout of the pumping station configuration for the DEP owned parcel, assuming a cavern configuration, is shown above on Figure 8-18. The layout for a site in the vicinity of the Newtown Creek WWTP for the longer tunnel option would be similar. The configurations of the diversion structures and drop shafts for Outfalls NC-015 and NC-083 would be similar to the arrangements shown in Figure 8-19 above for all the potential alignments of this alternative. For the short tunnel from the DEP site, the arrangement at Outfall NC-077 would be similar to the arrangement shown in Figure 8-20. For the long tunnel alignment to the vicinity of the Newtown Creek WWTP, the arrangement of diversion structures/drop shafts would be as shown in Figure 8-21. As with Alternatives DT-1, DT-2and DT-3, the drop shafts would include influent trash racks/grit sumps and passive odor control if determined to be necessary during design. Table 8-10 above summarizes the features of Alternatives DT-4a, DT-4b, DT-4c and DT-4d.

The benefits, costs and challenges associated with this tunnel storage alternative are as follows:

Benefits

The primary benefit of tunnel storage is the high level of CSO volume reduction with minimal permanent above-ground land requirements and disruption during construction. The single tunnel facility addresses three of the largest CSO discharge locations to Newtown Creek.

Benefits of the long tunnel with TDPS in the vicinity of the Newtown Creek WWTP over the short tunnel with TDPS at the DEP site include that the long dewatering force main from the DEP site would be eliminated, along with the risks of sediment deposition in the Morgan Avenue interceptor from the dewatering flow. This site would also be much closer to the Newtown Creek WWTP, making access to the TDPS easier from the Newtown Creek WWTP.

Cost

The estimated NPW for this control measure is $942M for Alternative DT-3a (WWTP site/Creek route), $992M for Alternative DT-3b (WWTP site/ROW route), $983M for Alternative DT-3c (DEP site/Creek route) and $986M for Alternative DT-3d (DEP site/ROW route). Details of the estimates are presented in Section 8.4.

Challenges

The challenges associated with these tunnel alternatives would be similar to the challenges identified for the DT-2 alternatives for 50 percent control and DT-3 for 62.5 percent control, with the additional challenge of siting and operating an RTB to allow 24-hour dewatering of the tunnel.

Alternatives DT-4a, DT-4b, DT-4c and DT-4d were carried forward to the next level of evaluation for inclusion in the basin-wide alternatives.

Alternative DT-5 – 100 Percent CSO Control Tunnel for Outfalls BB-026, NC-015, NC-083 and NC-077

The tunnels designated as Alternatives DT-5a and DT-5b would provide 100 percent CSO control for Outfall BB-026 in addition to Outfalls NC-015, NC-083 and NC-077. The tunnel launching shaft and dewatering pumping station would be located in the vicinity of the Newtown Creek WWTP. The tunnel alignments would either follow the Creek alignment or the ROW alignment, as shown in Figure 8-17 above. The tunnel internal diameters would range from 36 ft to 42 ft, depending on the route. Upon completion of the tunnel, a dewatering pumping station would be constructed. As described for Alternatives DT-1, DT-2, DT-3 and DT-4, the TDPS was assumed to be a cavern pumping station. The dewatering pumping station capacity required to dewater the tunnel in 24 hours would be 137 MGD to 142 MGD depending on the tunnel route. However, as noted above, based on considerations of loadings to the Newtown Creek WWTP, the maximum dewatering rate would be 40 MGD. To dewater within 24 hours would require 97 to 103 MGD of additional treatment for the dewatered flow. The 100 MGD RTB would require an approximately 2.5-acre site. The layout of the dewatering pumping station configuration assuming a cavern configuration would be similar to the layout shown in Figure 8-18. The configurations of the diversion structures and drop shafts for Outfalls NC-015 and NC-083 would be similar to the arrangements shown in Figure 8-19 above for all the potential alignments of this alternative. The arrangement of diversion structures/drop shafts for Outfall NC-077 would be as shown in Figure 8-21. For Outfall BB-026, a consolidation conduit would be routed from a diversion structure at the outfall to a drop shaft adjacent to the mining shaft in the vicinity of the Newtown Creek WWTP. It may be possible to incorporate the drop shaft for the BB-026 flows into the mining shaft structure. As with Alternatives DT-1, DT-2, DT-3 and DT-4, the drop shafts would include influent trash racks/grit sumps and passive odor control if determined to be necessary during design. Table 8-10 above summarizes the features of Alternatives DT-5a and DT-5b.

The benefits, costs and challenges associated with this tunnel storage alternative are as follows:

<u>Benefits</u>

The benefits would be similar to those identified for the DT-3, 75 percent control alternatives, but the volume controlled would be greater.

<u>Cost</u>

The estimated NPW for this control measure is $1.6B for both Alternative DT-5a (WWTP site/creek route) and Alternative DT-5b (WWTP site/ROW route). Details of the estimates are presented in Section 8.4.

<u>Challenges</u>

The challenges associated with these tunnel alternatives would be similar to the challenges identified for the DT-2, DT-3 and DT-4 alternatives for 50, 62.5 and 75 percent control, with the additional challenge of installing the micro-tunneled connection from Outfall BB-026, and providing a much larger RTB (100 MGD) for the dewatering flows.

Alternatives DT-5a and DT-5b were carried forward to the next level of evaluation for inclusion in the basin-wide alternatives.

8.2.b Future Scalability of Tunnel Alternatives

The scalability opportunities for the tunnel alternatives depend on whether the mining shaft/TDPS is located in the vicinity of the Newtown Creek WWTP or the DEP site. If the shaft is located at the DEP site, and a site in the vicinity of the Newtown Creek WWTP remained available, then a future phase could potentially extend the tunnel from the DEP site to the vicinity of the Newtown Creek WWTP, providing additional storage capacity and higher levels of CSO control. However, an RTB would be required for treatment of the higher tunnel dewatering flows. If the shaft is located in the vicinity of the Newtown Creek WWTP, then a future scalability scenario would require the addition of an RTB facility to provide treatment of flows in excess of the tunnel capacity. These scenarios would likely require land acquisition either through a negotiated acquisition or eminent domain. These alternatives would also include providing additional pumping capacity to the RTB. Siting of the RTB would be a challenge.

8.2.c Other Future Green Infrastructure (Various Levels of Penetration)

As discussed in Section 5, DEP projects that GI should result in a CSO volume reduction to Newtown Creek of approximately 83 MGY, based on the 2008 baseline rainfall condition. This projected GI has been included as part of the baseline model projections, and is thus not categorized as an LTCP alternative.

For the purpose of this LTCP, "Other Future Green Infrastructure" is defined as GI alternatives that are in addition to those implemented under previous facility plans and those included in the baseline conditions. Because DEP is working on the implementation of GI area-wide contracts in the Newtown Creek watershed, additional GI beyond the baseline is not being considered for this LTCP at this time. DEP's goal is to saturate priority watersheds, such as Newtown Creek, with GI to maximize benefits and cost-effectiveness based on the specific opportunities, as discussed in Section 5.

8.2.d Hybrid Green/Grey Alternatives

Hybrid green/grey alternatives are those that combine traditional grey control measures with GI control measures, to achieve the benefits of both. However, as discussed above, development of the baseline GI projects for this watershed is already underway and further GI is not planned at this time. Therefore, no controls in this category are proposed for the Newtown Creek LTCP.

8.2.e Retained Alternatives

The goal of the previous evaluations was the development of a list of retained control measures for Outfalls BB-026, NC-077, NC-083 and NC-015 to Newtown Creek. These control measures, whether individually or in combination, will form the basis of basin-wide alternatives that will be assessed using the more rigorous cost-performance and cost-attainment analyses. That list is presented in Table 8-11. The reasons for excluding the non-retained control measures from further consideration are also noted in the table.

Table 8-11. Summary of Next Level of Control Measure Screening

Control Measure	Category	Retained for Further Analysis?	Remarks
Additional GI Build-out	Source Control	NO	Planned GI build-out in the watershed (included in the baseline) is in development; unlikely that additional sites will be identified due to site constraints in publicly owned properties.
High Level Sewer Separation	Source Control	NO	Concern with resulting stormwater related pollution and construction impacts.
Fixed Weirs	System Optimization	NO	No CSO reduction benefit.
Parallel Interceptor Sewer	System Optimization	NO	Significant constructability challenges.
Pumping Station Optimization	System Optimization	NO	Limited benefit due to capacity limitation in Morgan Avenue interceptor.

Table 8-11. Summary of Next Level of Control Measure Screening

Control Measure	Category	Retained for Further Analysis?	Remarks
Pumping Station Expansion	System Optimization	YES	Borden Avenue PS (BAPS) expansion reduces CSO discharges to Dutch Kills and provides synergies with a SOGR intervention.
Gravity Flow Tipping to Other Watersheds	CSO Relocation	NO	No alternatives evaluated were determined to provide significant opportunity to warrant pursuing this solution further.
Flow Tipping with Conduit and Pumping	CSO Relocation	YES	BAPS expansion also falls into this category.
Floatables Control	Floatables Control	~~NO~~YES	~~Not evaluated as a separate CSO control measure.~~ Baseline conditions include floatables control at four largest outfalls. Underflow baffles were evaluated for the next three largest outfalls (BB-009, BB-013, and NCQ-029). Baffles were determined to be not feasible at outfall BB-013. The need for implementation of floatables control at outfalls BB-009 and NCQ-029 to be determined based on a floatables monitoring program to be implemented by DEP.
Environmental Restoration	Water Quality/ Ecological Enhancement	NO	EPA is evaluating dredging alternatives under Superfund; wetlands restoration could be required after dredging.
In-Stream Aeration	Water Quality/ Ecological Enhancement	NO	Gap analysis indicated Dutch Kills aeration system not required for average annual attainment of DO criterion.
Flushing Tunnel	Water Quality/ Ecological Enhancement	NO	Not practical for upstream reaches, not cost-effective compared to BAPS expansion for Dutch Kills.
Outfall Disinfection	Treatment: Satellite	NO	Very limited CSO control benefit.
Retention/Treatment Basins	Treatment: Satellite	NO	Alternative RTB-1 evaluated a 152 MGD RTB in conjunction with a consolidation conduit. High risk associated with long near-surface construction.
In-System Storage (Outfalls)	Storage	NO	Very limited levels of CSO control.
Off-line Storage (Shafts)	Storage	NO	Limited capacity would require multiple shafts; limited number of existing facilities from which to judge performance/ operational issues.
Off-line Storage (Tanks)	Storage	YES	To provide perspective on tunnel costs for equivalent levels of control.
Off-line Storage (Tunnels)	Storage	YES	Tunnels were evaluated under Alternatives DT-1, DT-2, DT-3 and DT-4.

As shown, the retained control measures include the BAPS expansion, storage tanks and deep tunnel storage. Floatables control is indicated in Table 8-11 as "retained, but the need for an underflow baffle at outfall BB-009 and an underflow baffle with bending weir at outfall NCQ-029 will be determined based on a floatables monitoring program to be implemented for those two outfalls. If those floatables control projects are determined to be required, they would be common elements to each of the other retained alternatives. Since the need for these floatables control projects is not certain at this time, the costs for the other retained alternatives presented below do not include the costs for floatables control at outfalls BB-009 and NCQ-029. ~~Measures for additional and/or improved floatables control are addressed within the retained alternatives.~~

8.3 CSO Reductions and Water Quality Impact of Retained Alternatives

To evaluate effects on the loadings and water quality CWA impacts, the retained alternatives listed in Table 8-12 were analyzed using both the Newtown Creek watershed (IW) and receiving water quality (NCRWQM) models. Evaluations of levels of CSO control for each alternative are presented below. In all cases, the predicted reductions shown are relative to the baseline conditions using 2008 JFK rainfall as described in Section 6. The baseline assumptions were described in detail in Section 6 and assume that the grey infrastructure projects from the WWFP have been implemented, along with the GI projected implementation identified in Section 5.

As noted earlier, a SOGR upgrade of the BAPS targeting an additional wet-weather pumping capacity of up to 24 MGD (75 percent CSO control at Outfall BB-026) was selected as the most favorable solution to mitigate the impacts of CSO discharges to Dutch Kills. Because the existing BAPS serves another small drainage area associated with Regulator BBL3a, whose flow contribution would also be pumped to the Newtown Creek WWTP during wet-weather, the total installed capacity at the BAPS would need to be 26 MGD to provide the targeted 75 percent CSO control at Outfall BB-026, 14 MGD to provide 50 percent CSO control and 7 MGD to provide 25 percent CSO control. Table 8-12 presents the annual and recreational season (May 1st through October 31st) activation frequencies at BB-026, the percent attainment of the Primary Contact WQ bacteria criteria based on 2008 rainfall, the PBC and NPW for the range of levels of control considered for the BAPS alternative. As shown in Table 8-12, implementation of at least 50 percent CSO control at Outfall BB-026 would bring Dutch Kills to seasonal attainment of the Primary Contact WQ fecal coliform criterion at WQ Station NC-6, which is the station closest to the Outfall. The locations of Outfall BB-026 and WQ Station NC-6 are shown in Figure 6-2. This assessment was conducted assuming equivalent levels of CSO control at Outfalls NC-077, NC-083 and NC-015. Table 8-12 also shows that implementing a 75 percent level of CSO control at Outfall BB-026, leads to elimination of four additional CSO activations in the recreational season (May 1st through October 31$^{st)}$. The NPW shown are described with more detail in Section 8-4.

Table 8-12. Summary of Performance for BAPS Alternatives

Outfall BB-026	Annual Activation Frequency	Seasonal Activation Frequency	2008 Seasonal Fecal Coliform Attainment (%)	PBC ($M)	NPW ($M)
Baseline	37	20	83	-	-
25% Control	35	15	>95	39	51

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Table 8-12. Summary of Performance for BAPS Alternatives

Outfall BB-026	Annual Activation Frequency	Seasonal Activation Frequency	2008 Seasonal Fecal Coliform Attainment (%)	PBC ($M)	NPW ($M)
50% Control	29	9	>95	44	59
75% Control	25	5	>95	50	71

As mentioned in Section 8.2, 100 percent CSO control at Outfall BB-026 would be more effectively accomplished by conveying the typical year CSO discharges to a storage tunnel that would also target the capture of the discharges from Outfalls NC-077, NC-083 and NC-015. Through analysis of various tunneling options, it was possible to assign an additional PBC of $130M to the tunnel expansion scope required to retain and dewater the additional volume from Outfall BB-026. Neglecting the nominal increase in O&M cost associated with capturing the BB-026 volume, Figure 8-22 shows a clear knee-of-the-curve (KOTC) at the 75 percent level of control, based on PBCs. Expanding the BAPS up to 26 MGD to achieve 75 percent CSO control at Outfall BB-026 is the most cost-effective alternative for this outfall.

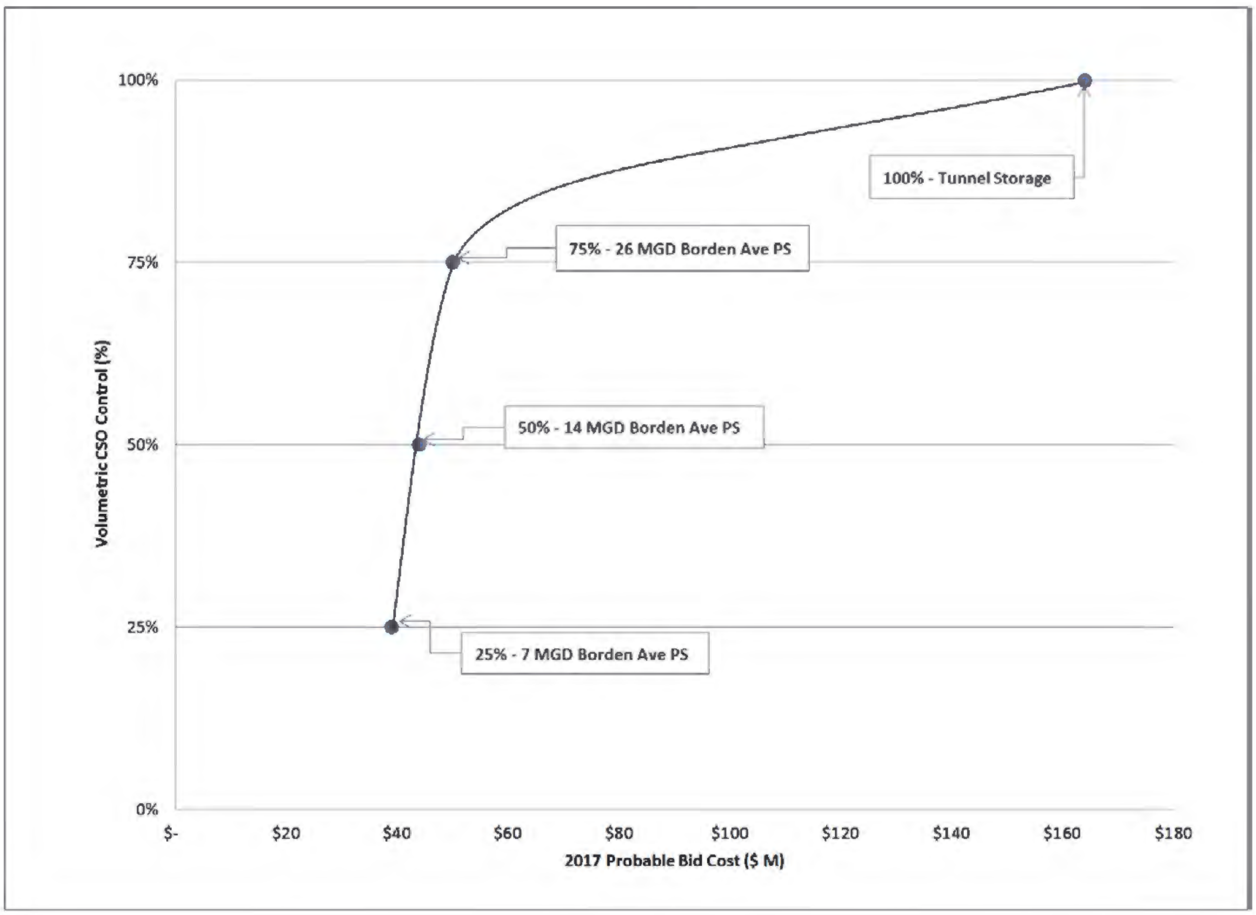

Figure 8-22. Probable Bid Cost vs Volumetric CSO Level of Control at Outfall BB-026

As noted above, elimination of the Phase 4 of Enhanced Aeration covering Dutch Kills and part of lower Newtown Creek will result in a $30.8M savings. Basin-wide alternatives were developed based on the combination of a 26 MGD expansion of the BAPS and CSO control tunnels or individual storage tanks for Outfalls NC-077, NC-083 and NC-015. Table 8-13 presents the resulting alternatives along with their new sequential numbering system. As shown, six basin-wide alternatives were included that target the largest, most active outfalls, BB-026, NC-077, NC-083 and NC-015. The evaluation of floatables control for outfalls BB-009, BB-013, and NCQ-029 would not affect the assessment of CSO volumes and loads, or WQS attainment for the basin-wide alternatives. The costs of the floatables control for outfalls BB-009, BB-013, and NCQ-029 are therefore not included in the basin-wide alternatives assessment presented below.

Table 8-13. Basin-Wide Alternatives with New Sequential Numbering

Alternative	Remarks
1. 26 MGD BAPS Expansion and Deep Tunnel for 25% Control of Three Largest Outfalls	16 foot interior diameter deep Tunnel with lengths ranging from 7,570 to 9,980 feet
2. 26 MGD BAPS Expansion and Individual Storage Tanks for 25% Control of Three Largest Outfalls	Volumes of Individual storage tanks: • NC-077 – 2.4 MG • NC-083 – 3.0 MG • NC-015 – 4.3 MG
3. 26 MGD BAPS Expansion and Deep Tunnel for 50% Control of Three Largest Outfalls	16 to 26 foot interior diameter Deep Tunnels with lengths ranging from 7,570 to 18,800 feet
4. 26 MGD BAPS Expansion and Individual Storage Tanks for 50% Control of Three Largest Outfalls	Volumes of Individual storage tanks: • NC-077 – 6.9 MG • NC-083 – 8.5 MG • NC-015 – 12.3 MG
5. 26 MGD BAPS Expansion and Deep Tunnel for 62.5% Control of Three Largest Outfalls	19 to 30 foot interior diameter Deep Tunnels with lengths ranging from 7,570 to 18,800 feet
6. 26 MGD BAPS Expansion and Deep Tunnel for 75% Control of Three Largest Outfalls	23 to 26 foot interior diameter Deep Tunnel with lengths ranging from 7,570 to 18,800 feet; 20 MGD RTB for dewatering flows
7. Deep Tunnel for 100% Control of Four Largest Outfalls	36 to 42 foot interior diameter Deep Tunnel with lengths ranging from 13,700 to 18,800 feet; 100 MGD RTB for dewatering flows

These seven Newtown Creek basin-wide retained alternatives were then analyzed on the basis of their cost-effectiveness in reducing loads and improving water quality. These more advanced analyses are described in Sections 8.3, 8.4 and 8.5.

8.3.a CSO Volume and Bacteria Loading Reductions of Basin-Wide Retained Alternatives

Table 8-14 summarizes the projected performance of the retained Newtown Creek basin-wide alternatives in terms of CSO volume, fecal coliform and *Enterococci* load reduction. These data are plotted on Figure 8-23.

Table 8-14. Newtown Creek Retained Alternatives Performance Summary (2008 Rainfall)

Alternative	CSO Volume (MGY) (3)	Frequency of Overflow(4)	CSO Volume Reduction(3) (%)	Fecal Coliform Reduction(1)(3) (%)	*Enterococci* Reduction(1)(3) (%)
Baseline Conditions(2)	1,055	42	-	-	-
1. 26 MGD BAPS Expansion and Deep Tunnel for 25% Control of Three Largest Outfalls	696	29	34	29	37
2. 26 MGD BAPS Expansion and Individual Storage Tanks for 25% Control of Three Largest Outfalls	696	29	34	29	37
3. 26 MGD BAPS Expansion and Deep Tunnel for 50% Control of Three Largest Outfalls	475	29	55	53	58
4. 26 MGD BAPS Expansion and Individual Storage Tanks for 50% Control of Three Largest Outfalls	475	19	55	52	57
5. 26 MGD BAPS Expansion and Deep Tunnel for 62.5% Control of Three Largest Outfalls	364	19	65	63	68
6. 26 MGD BAPS Expansion and Deep Tunnel for 75% Control of Three Largest Outfalls	286	18	73	70	75
7. Deep Tunnel for 100% Control of Four Largest Outfalls	0	0	100	100	100

Notes:
(1) Bacteria reduction is computed on an annual basis.
(2) Based upon 2008 Typical Year.
(3) Maximum values reported for four largest outfalls (BB-026, NC-077, NC-083 and NC-015).
(4) Maximum values for the three upstream outfalls (NC-077, NC-083 and NC-015); annual frequency for BB-026 is 25.

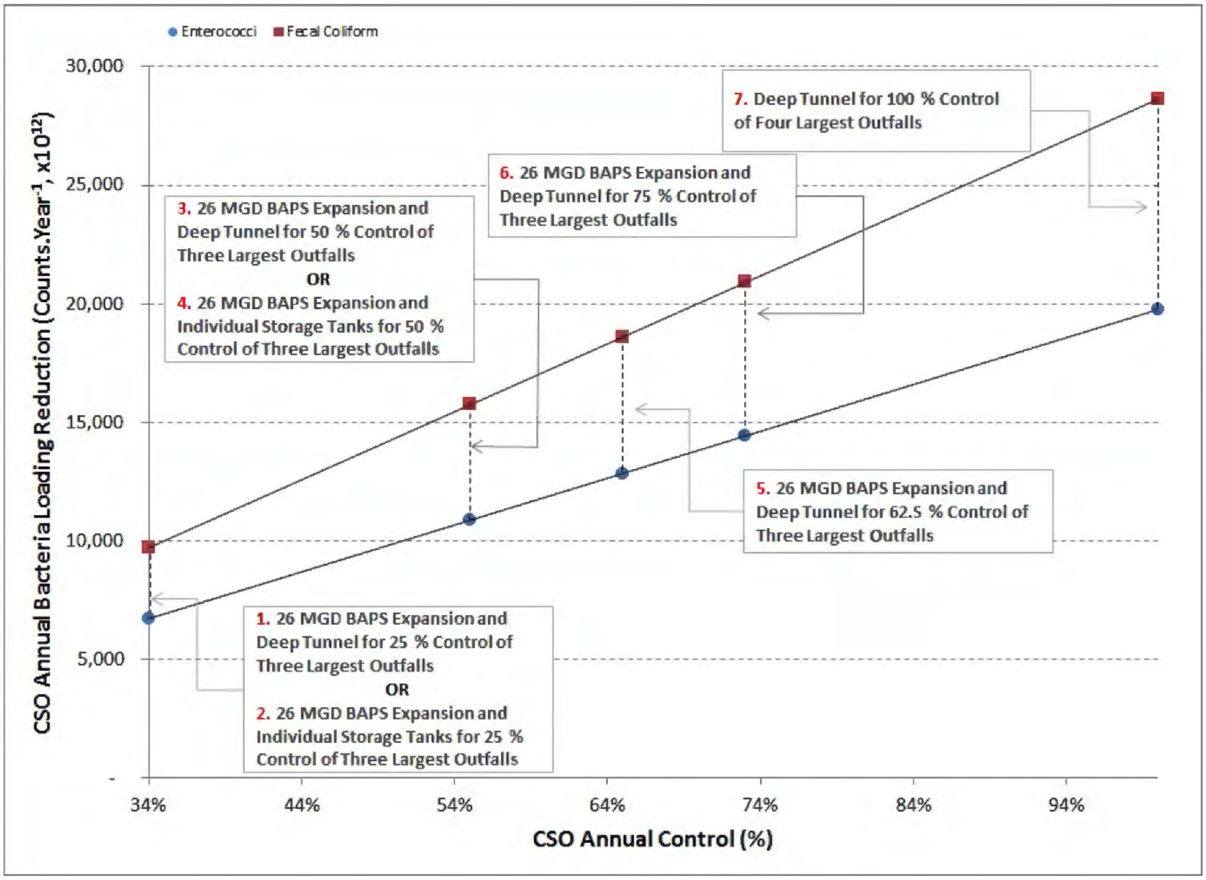

Figure 8-23. Untreated CSO Volume Reductions (as Percent CSO Annual Control) vs. Annual CSO Bacteria Loading Reduction (2008 Rainfall)

The bacteria loading reductions shown in Table 8-14 were computed on an annual basis. Because the retained alternatives for Newtown Creek provide volume reduction and not treatment, the predicted bacteria loading reductions of the alternatives are very closely aligned with their projected CSO volume reductions.

8.3.b Water Quality Impacts Within Newtown Creek

Due to the geographic location of Dutch Kills relative to the other tributary branches, the analysis of water quality impacts to the waterbody was segmented accordingly below:

<u>CSO reduction at Outfall BB-026 and WQ improvements at WQ Station NC-6</u>

The evaluation of the improvements to the WQ in Dutch Kills upon implementation of various levels of CSO control focused on WQ Station NC-6 and CSO Outfall BB-026, both close to the head end of the tributary branch. This assessment was conducted assuming equivalent levels of CSO control at Outfalls NC-077, NC-083 and NC-015. As discussed in Section 8.2 and above in this section, the preferred solution is to provide 75 percent CSO control at Outfall BB-026 by an expansion of the BAPS to 26 MGD. The cost for 100 percent control is based on the incremental cost to connect Outfall BB-026 to a tunnel storage alternative. Figure 8-24 presents the NPW of the various alternatives for BB-026 versus annual and recreational season (May 1st through October 31st) attainment of the Existing Primary Contact WQ Criteria, as well as attainment of the Potential Future Primary Contact WQ Criteria. The attainment in

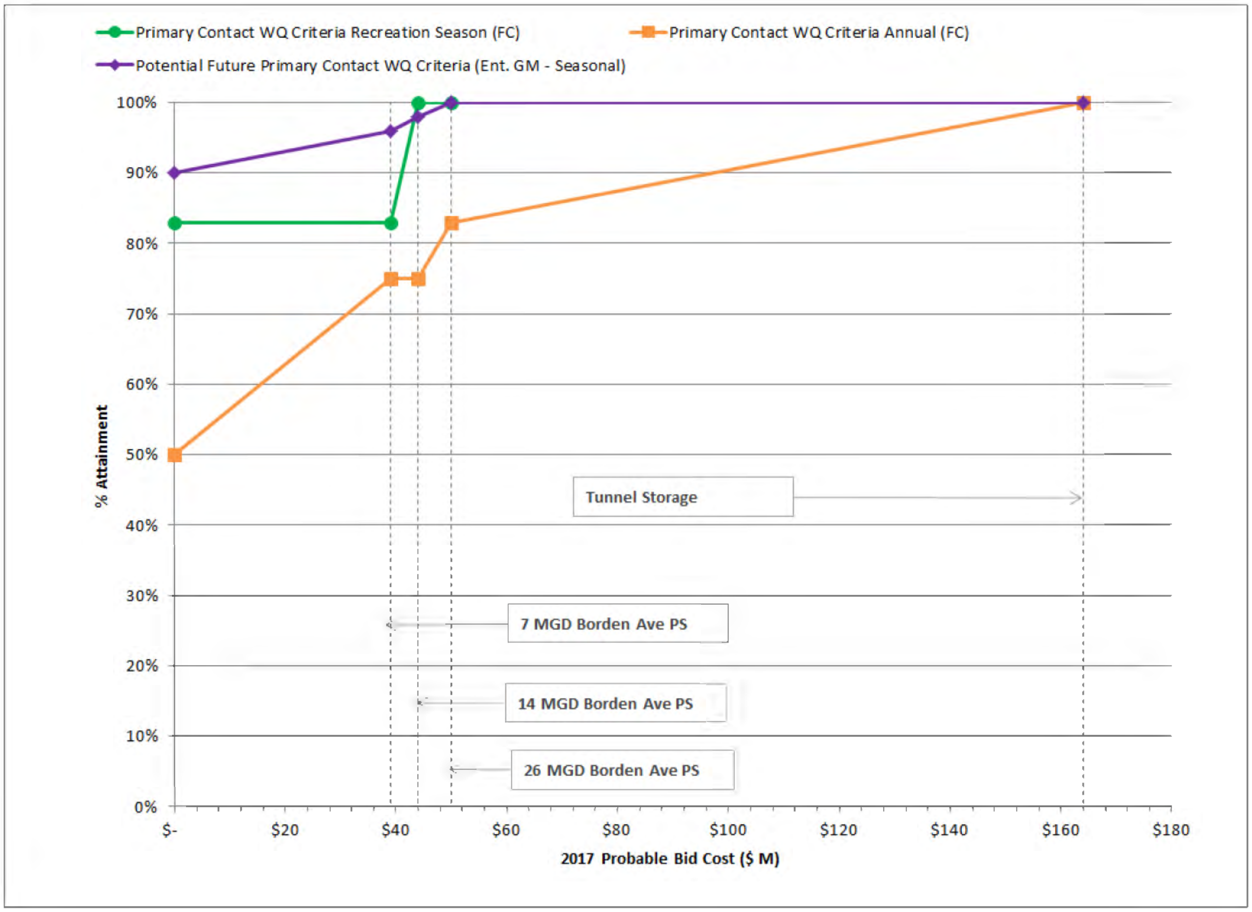

Figure 8-24. Probable Bid Cost vs Attainment at Outfall BB-026

these plots is based on the 2008 typical year. These plots further support selection of the 75 percent level of control alternative as the preferred alternative for BB-026.

Basin-wide Alternatives 1 through 7 and WQ Improvements to Newtown Creek and Tributary Branches

This section describes the levels of attainment with applicable current and potential future bacteria criteria within Newtown Creek that would be achieved through implementation of the basin-wide retained CSO control alternatives listed in Table 8-13.

Newtown Creek is a Class SD waterbody. Based on the analysis presented in Section 6.0, and supported by the NCRWQM runs for 2008 typical year, historic and recent water quality monitoring, along with baseline condition modeling, none of the stations within the waterbody are in attainment with the Primary Contact WQ Criteria for fecal coliform under baseline conditions. A review of the Potential Future Primary Contact Water Quality Criteria for *Enterococci* indicates that under baseline conditions, Newtown Creek would also not be in attainment of the rolling 30-day geomean criterion of 30 cfu/100mL and the 90th percentile standard threshold value criterion of 110 cfu/100mL. Upon implementation of at least 50 percent CSO control at Outfalls BB-026, NC-077, NC-083 and NC-015, recreational season (May 1st

through October 31st) attainment of the fecal coliform criterion would be achieved at all sampling locations except NC12 and NC14 for the 2008 typical year. NC12 and NC14 are located in the upstream reaches of East Branch and English Kills, respectively. Providing 62.5 percent CSO control would bring locations NC12 and NC14 into recreational season compliance based on the 2008 typical year. General aspects of the relationship between levels of CSO control through implementation of the retained alternatives and predicted levels of WQS attainment are discussed in greater detail in Section 8.5.

8.4 Cost Estimates for Retained Alternatives

Evaluation of the retained alternatives requires cost estimation. The methodology for developing these costs is dependent upon the type of technology and its O&M requirements. The construction costs were developed as PBC and the total NPW costs were determined by adding the estimated PBC to the NPW of the projected annual O&M costs at an assumed interest rate of 3 percent over a 20-year life cycle. However, for tunnel alternatives which provide longer service, a longer 100 year lifecycle was used for computing NPW. Design, construction management and land acquisition costs are not included in the cost estimates. All costs are in February 2017 dollars and are considered Level 5 cost estimates by AACE International with an accuracy of -50 percent to +100 percent.

8.4.a Alternative 1 – 26 MGD BAPS Expansion and 25 Percent Control Individual Tanks for Outfalls NC-015, NC-083 and NC-077

Costs for Alternative 1 include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the upgraded station. The costs also include construction of three storage tanks for Outfalls NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 1 is $627M as shown in Table 8-15.

Table 8-15. Costs for Basin-Wide Alternative 1

Item	February 2017 Cost ($ Million)		
	BAPS Expansion	Individual Storage Tanks	Total
Probable Bid Cost	50	513	563
Annual O&M Cost	1.4	2.9	4.3
Net Present Worth	71	556	627

8.4.b Alternative 2a – 26 MGD BAPS Expansion and 25 Percent Control Deep Tunnel for Outfalls NC-015, NC-083 and NC-077 (Creek Alignment/Shorter Tunnel)

Costs for Alternative 2a include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the station. The costs also include construction of a deep tunnel for Outfalls NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 2a is $508M as shown in Table 8-16.

Table 8-16. Costs for Basin-Wide Alternative 2a

Item	February 2017 Cost ($ Million)		
	BAPS Expansion	Storage Tunnel	Total
Probable Bid Cost	50	358	408
Annual O&M Cost	1.4	2.5	3.9
Net Present Worth	71	437	508

8.4.c Alternative 2b – 26 MGD BAPS Expansion and 25 Percent Control Deep Tunnel for Outfalls NC-015, NC-083 and NC-077 (ROW Alignment/Shorter Tunnel)

Costs for Alternative 2b include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the station. The costs also include construction of a deep tunnel for Outfalls NC-077, NC-083 and NC-015 and reflect the description provided in detail in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 2b is $527M as shown in Table 8-17.

Table 8-17. Costs for Basin-Wide Alternative 2b

Item	February 2017 Cost ($ Million)		
	BAPS Expansion	Storage Tunnel	Total
Probable Bid Cost	50	377	427
Annual O&M Cost	1.4	2.5	3.9
Net Present Worth	71	456	527

8.4.d Alternative 3 – 26 MGD BAPS Expansion and 50 Percent Control Individual Storage Tanks for Outfalls NC-015, NC-083 and NC-077

Costs for Alternative 3 include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the station. The costs also include construction of three storage tanks for Outfalls NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 3 is $901M as shown in Table 8-18.

Table 8-18. Costs for Basin-Wide Alternative 3

Item	February 2017 Cost ($ Million)		
	BAPS Expansion	Individual Storage Tanks	Total
Probable Bid Cost	50	776	826
Annual O&M Cost	1.4	3.6	5
Net Present Worth	71	830	901

8.4.e Alternative 4a - 26 MGD BAPS Expansion and 50 Percent Control Deep Tunnel for Outfalls NC-015, NC-083 and NC-077 (Creek Alignment)

Costs for Alternative 4a include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the station. The costs also include construction of a deep tunnel collecting overflows from Outfalls NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 4a ranges from $645M to $647M, as shown in Table 8-19.

Table 8-19. Costs for Basin-Wide Alternative 4a

Item	February 2017 Cost ($ Million)				
	BAPS Expansion	Shorter (DEP)		Longer (WWTP)	
		Tunnel	Total	Tunnel	Total
Probable Bid Cost	50	476	526	478	528
Annual O&M Cost	1.4	3.1	4.5	3.1	4.5
Net Present Worth	71	574	645	576	647

8.4.f Alternative 4b - 26 MGD BAPS Expansion and 50 Percent Control Deep Tunnel for Outfalls NC-015, NC-083 and NC-077 (ROW Alignment)

Costs for Alternative 4b include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the station. The costs also include construction of a deep tunnel for Outfalls NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 4b ranges from $642M to $647M as shown in Table 8-20.

Table 8-20. Costs for Basin-Wide Alternative 4b

Item	February 2017 Cost ($ Million)				
	BAPS Expansion	Shorter (DEP)		Longer (WWTP)	
		Storage Tunnel	Total	Storage Tunnel	Total
Probable Bid Cost	50	478	528	473	523
Annual O&M Cost	1.4	3.1	4.5	3.1	4.5
Net Present Worth	71	576	647	571	642

8.4.g Alternative 5a - 26 MGD BAPS Expansion and 62.5 Percent Control Deep Tunnel for Outfalls NC-015, NC-083 and NC-077 (Creek Alignment)

Costs for Alternative 5a include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the station. The costs also include construction of a deep tunnel collecting overflows from Outfalls NC-077, NC-083 and

NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 5a ranges from $717M to $722M, as shown in Table 8-21.

Table 8-21. Costs for Basin-Wide Alternative 5a

Item	February 2017 Cost ($ Million)				
	BAPS Expansion	Shorter (DEP)		Longer (WWTP)	
		Tunnel	Total	Tunnel	Total
Probable Bid Cost	50	539	589	534	584
Annual O&M Cost	1.4	3.6	5.0	3.6	5.0
Net Present Worth	71	651	722	646	717

8.4.h Alternative 5b - 26 MGD BAPS Expansion and 62.5 Percent Control Deep Tunnel for Outfalls NC-015, NC-083 and NC-077 (ROW Alignment)

Costs for Alternative 5b include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the station. The costs also include construction of a deep tunnel for Outfalls NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 5b ranges from $703M to $730M as shown in Table 8-22.

Table 8-22. Costs for Basin-Wide Alternative 5b

Item	February 2017 Cost ($ Million)				
	BAPS Expansion	Shorter (DEP)		Longer (WWTP)	
		Storage Tunnel	Total	Storage Tunnel	Total
Probable Bid Cost	50	520	570	547	597
Annual O&M Cost	1.4	3.6	5.0	3.6	5.0
Net Present Worth	71	632	703	659	730

8.4.i Alternative 6a – 26 MGD BAPS Expansion and 75 Percent Control Deep Tunnel for Outfalls NC-015, NC-083 and NC-077 (Creek Alignment)

Costs for Alternative 6a include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the station. The costs also include construction of a deep tunnel for Outfalls NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 6a ranges from $1.01B to $1.05B as shown in Table 8-23.

Table 8-23. Costs for Basin-Wide Alternative 6a

Item	February 2017 Cost ($ Million)				
	BAPS Expansion	Shorter (DEP)		Longer (WWTP)	
		Storage Tunnel	Total	Storage Tunnel	Total
Probable Bid Cost	50	787	837	745	795
Annual O&M Cost	1.4	6.0	7.4	6.0	7.4
Net Present Worth	71	983	1,054	942	1,013

8.4.j Alternative 6b – 26 MGD BAPS Expansion and 75 Percent Control Deep Tunnel for Outfalls NC-015, NC-083 and NC-077 (ROW Alignment)

Costs for Alternative 6b include planning-level estimates of the costs to expand the BAPS to provide 26 MGD pumping capacity and the construction of conveyance elements to and from the station. The costs also include construction of a deep tunnel for Outfalls NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 5b is approximately $1.06B as shown in Table 8-24.

Table 8-24. Costs for Basin-Wide Alternative 6b

Item	February 2017 Cost ($ Million)				
	BAPS Expansion	Shorter (DEP)		Longer (WWTP)	
		Storage Tunnel	Total	Storage Tunnel	Total
Probable Bid Cost	50	790	840	795	845
Annual O&M Cost	1.4	6.0	7.4	6.0	7.4
Net Present Worth	71	986	1,057	992	1,063

8.4.k Alternative 7a - 100 Percent Control Deep Tunnel for Outfalls BB-026, NC-015, NC-083 and NC-077 (Creek Alignment)

The costs for Alternative 7a include planning-level estimates for the construction of a deep tunnel for Outfalls BB-026, NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 7a is $1.65B, as shown in Table 8-25.

Table 8-25. Costs for Basin-Wide Alternative 7a

Item	February 2017 Cost ($ Million)
Probable Bid Cost	1,371
Annual O&M Cost	8.8
Net Present Worth	1,649

8.4.l Alternative 7b – 100 Percent Control Deep Tunnel for Outfalls BB-026, NC-015, NC-083 and NC-077 (ROW Alignment)

Costs for Alternative 7b include planning-level estimates of the costs construction of a deep tunnel collecting overflows from Outfalls BB-026, NC-077, NC-083 and NC-015 and reflect the description provided in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 6b is $1.65B, as shown in Table 8-26.

Table 8-26. Costs for Basin-Wide Alternative 7b

Item	February 2017 Cost ($ Million)
Probable Bid Cost	1,373
Annual O&M Cost	8.8
Total Net Present Worth	1,650

The cost estimates of these retained alternatives are summarized below in Table 8-27 and are then used in the development of the cost-performance and cost- attainment plots presented in Section 8.5. For the purposes of the cost-performance and cost-attainment curves development, costs for the tunnel options whose alignment follows the Creek to the extent possible were used. These costs do not differ significantly from those estimated for the ROW alignments. As noted above, elimination of the Phase 4 of Enhanced Aeration covering Dutch Kills and part of lower Newtown Creek will result in a $30.8M savings that would be applicable to all basin-wide alternatives.

Table 8-27. Cost of Retained Alternatives

Alternative	February 2017 PBC ($ Million)	Annual O&M Cost ($ Million)	Total Net Present Worth ($ Million)
1. 26 MGD BAPS Expansion and Individual Storage Tanks for 25 % Control of Three Largest Outfalls	563	4.3	627
2a. 26 MGD BAPS Expansion and Deep Tunnel for 25% Control of Three Largest Outfalls- Creek Alignment(1)(2)	408	3.9	508
2b. 26 MGD BAPS Expansion and Deep Tunnel for 25% Control of Three Largest Outfalls (Row Alignment)(1)	427	3.9	527
3. 26 MGD BAPS Expansion and Individual Storage Tanks for 50% Control of Three Largest Outfalls (1)	826	5	901
4a. 26 MGD BAPS Expansion and Deep Tunnel for 50% Control of Three Largest Outfalls (Creek Alignment)(1)(2)	526 to 528	4.5	645 to 647
4b. 26 MGD BAPS Expansion and Deep Tunnel for 50% Control of Three Largest Outfalls (ROW Alignment)(1)	523 to 528	4.5	642 to 647
5a. 26 MGD BAPS Expansion and Deep Tunnel for 62.5% Control of Three Largest Outfalls (Creek Alignment)(1)(3)	584 to 589	5.0	717 to 722
5b. 26 MGD BAPS Expansion and Deep Tunnel for 62.5% Control of Three Largest	570 to 597	5.0	703 to 730

Table 8-27. Cost of Retained Alternatives

Alternative	February 2017 PBC ($ Million)	Annual O&M Cost ($ Million)	Total Net Present Worth ($ Million)
Outfalls (ROW Alignment)(1)			
6a. 26 MGD BAPS Expansion and Deep Tunnel for 75% Control of Three Largest Outfalls (Creek Alignment)(1)(4)	795 to 837	7.4	1,013 to 1,054
6b. 26 MGD BAPS Expansion and Deep Tunnel for 75% Control of Three Largest Outfalls (ROW Alignment)(1)	840 to 845	7.4	1,057 to 1,063
7a. Deep Tunnel for 100% Control of Four Largest Outfalls (Creek Alignment)(1)(2)	1,371	8.8	1,649
7b. Deep Tunnel for 100% Control of Four Largest Outfalls (ROW Alignment)(1)	1,373	8.8	1,650

Notes:

(1) Both the WWTP and DEP sites were used for the purposes of developing conceptual layouts for evaluation of 25, 50, 75 and 100% CSO control tunnel alternatives. The final siting of the TDPS, the tunnel alignment and other associated details of the tunnel alternatives presented herein will be further evaluated and finalized during subsequent planning and design stages.

(2) Tunnel alternative shown in subsequent cost-performance and cost-attainment plots.

(3) Tunnel alternative with higher NPW of $722M shown in subsequent cost-performance and cost-attainment plots.

(4) Tunnel alternative with higher NPW of $1,054M shown in subsequent cost-performance and cost-attainment plots.

8.5 Cost-Attainment Curves for Retained Alternatives

The final step of the analysis is to evaluate the cost-effectiveness of the basin-wide retained alternatives based on their NPW and projected impact on CSO loadings and attainment of applicable WQS. Those retained alternatives that did not show incremental gains in performance (shown in red in the figures) were not included in the development of the best-fit curve.

8.5.a Cost-Performance Curves

Cost-performance curves were developed by plotting the costs of the retained alternatives against their predicted level of CSO control. For the purposes of this section, CSO control is defined as the degree or rate of bacteria reduction through volumetric capture. Both the cost-performance and subsequent cost-attainment analyses focus on bacteria loadings and bacteria WQ criteria.

A best-fit cost curve was developed based on those alternatives judged most cost-effective for a defined level of CSO control as estimated by IW modeling for the typical year rainfall (2008).

DEP also evaluated the level of bacteria loadings reductions to the receiving waters. Figure 8-25 shows the percent reductions on a volumetric basis achieved by each alternative whereas Figure 8-26 illustrates the CSO events remaining upon implementation of each alternative. Bacteria load reduction plots are presented in Figures 8-27 (*Enterococci*) and 8-28 (fecal coliform). These curves plot the cost of the alternatives against their associated projected annual CSO *Enterococci* and fecal coliform loading reductions, respectively. The primary vertical axis shows percent CSO bacteria loading reductions. The secondary vertical axis shows the corresponding total bacteria loading reductions, as a percentage, when loadings from other non-CSO sources of bacteria are included. Figures 8-25, 8-27 and 8-28 show a KOTC at the alternative with the 62.5 percent control tunnel.

The evaluation of the retained alternatives focused on cost-effective reduction of the frequency of CSO discharge in addition to CSO volume and pathogen load reductions to address current impacts to waterbody uses and issues raised by the public.

8.5.b Cost-Attainment Curves

This section evaluates the relationship of the costs of the retained alternatives versus their expected level of attainment of bacteria Primary Contact WQ Criteria and Potential Future Primary Contact WQ Criteria as modeled using NCRWQM with 2008 rainfall. The cost-performance plots shown in Figures 8-25 through 8-28 indicate that most of the retained alternatives represent incremental gains in marginal performance. Those retained alternatives that did not show incremental gains in marginal performance on the cost-performance curves are not included in the cost-attainment curves as they were deemed not to be cost-effective relative to other alternatives.

In addition to the bacteria Primary Contact WQ Criteria, the cost-attainment analysis considered Potential Future Primary Contact WQ Criteria. As was noted in Section 2.0, under the BEACH Act of 2000, *Enterococci* criteria do not apply to tributaries such as Newtown Creek, which is not a coastal recreation water and does not have primary contact recreation as a designated use. The bacteria standards evaluations thus only considered the fecal coliform criterion, specifically the monthly GM of 200 cfu/100mL both on an annual and recreational season (May 1st through October 31st) basis. The resultant curves for the current and potential future standards and relevant criteria are presented as Figures 8-29 through 8-40 for eleven locations (Stations OW-4 through OW-14) within Newtown Creek.

Based on the 2008 typical year WQ simulations for Newtown Creek, annual or seasonal attainment of the Existing WQ (Class SD) or Primary Contact WQ Criteria for fecal coliform under baseline conditions are not satisfied 100 percent of the time.

Upon implementation of at least 50 percent CSO control at Outfalls BB-026, NC-077, NC-083 and NC-015, recreational season (May 1st through October 31st) attainment of the fecal coliform criterion would be achieved at all sampling locations except NC12 and NC14 for the 2008 typical year. NC12 and NC14 are located in the upstream reaches of East Branch and English Kills, respectively. Providing 62.5 percent CSO control would bring locations NC12 and NC14 into recreational season compliance based on the 2008 typical year.

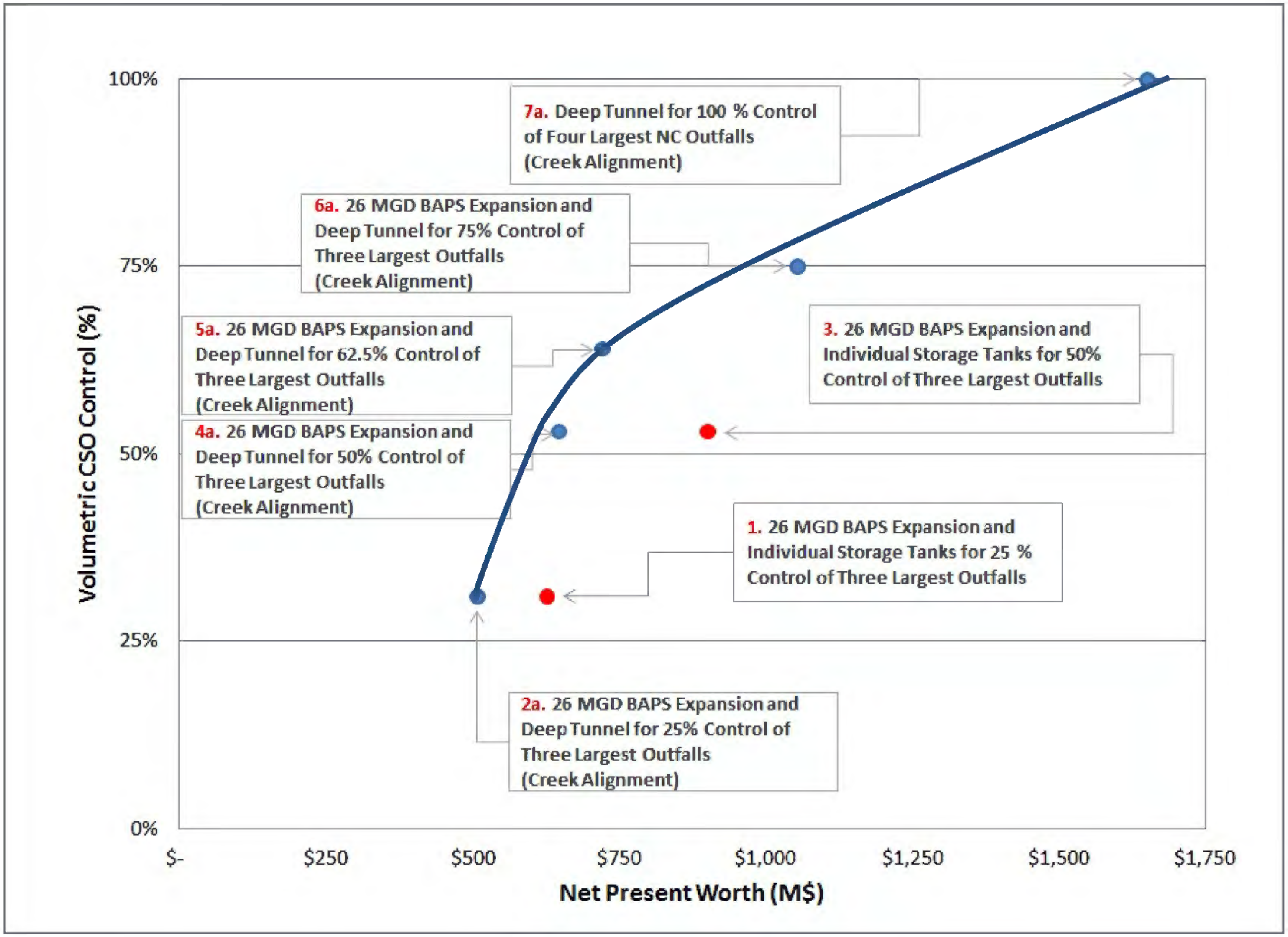

Figure 8-25. Cost vs. CSO Control (2008 Rainfall)

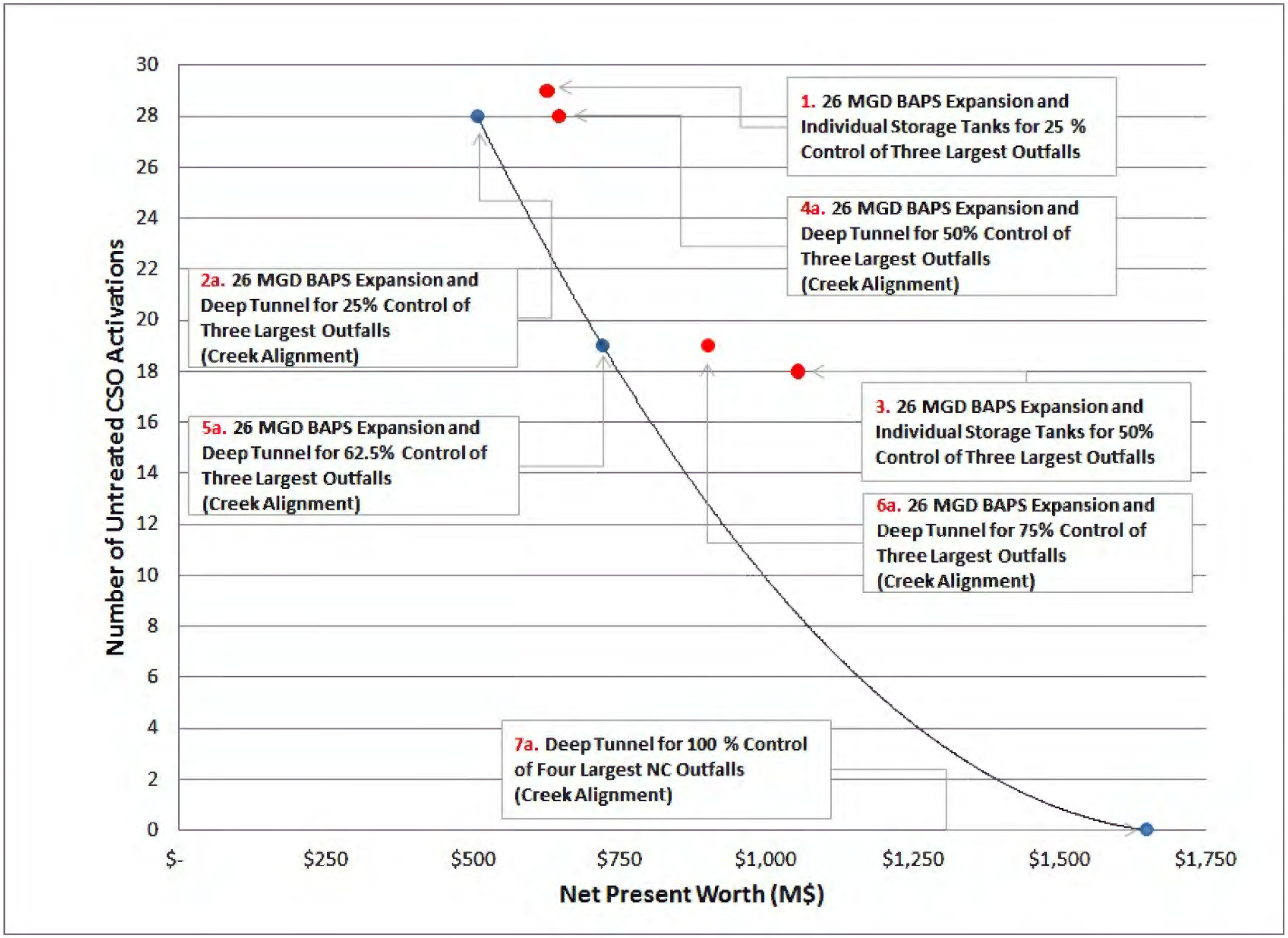

Figure 8-26. Cost vs. Remaining CSO Events (2008 Rainfall)

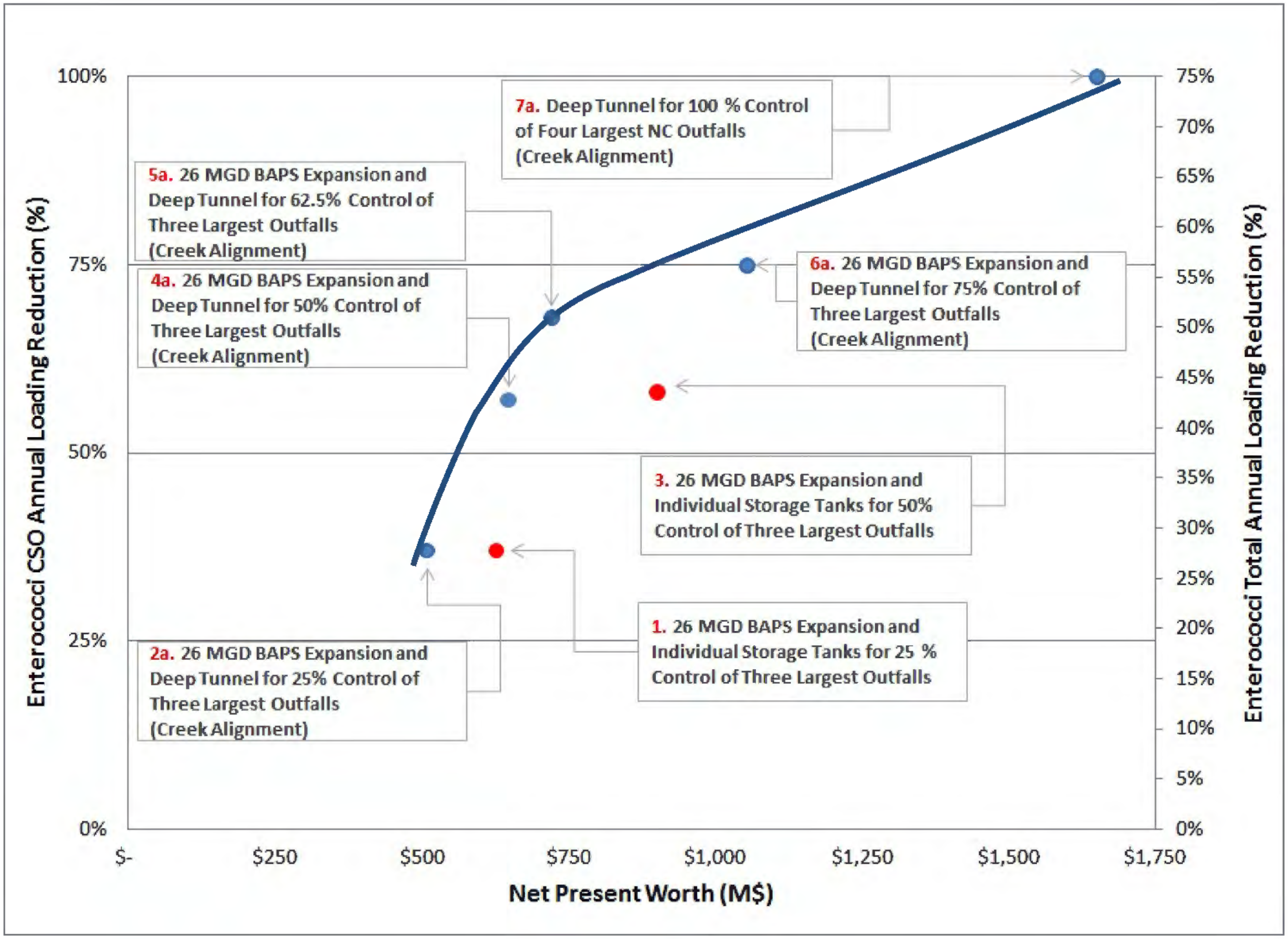

Figure 8-27. Cost vs. *Enterococci* Loading Reduction (2008 Rainfall)

AECOM with Hazen

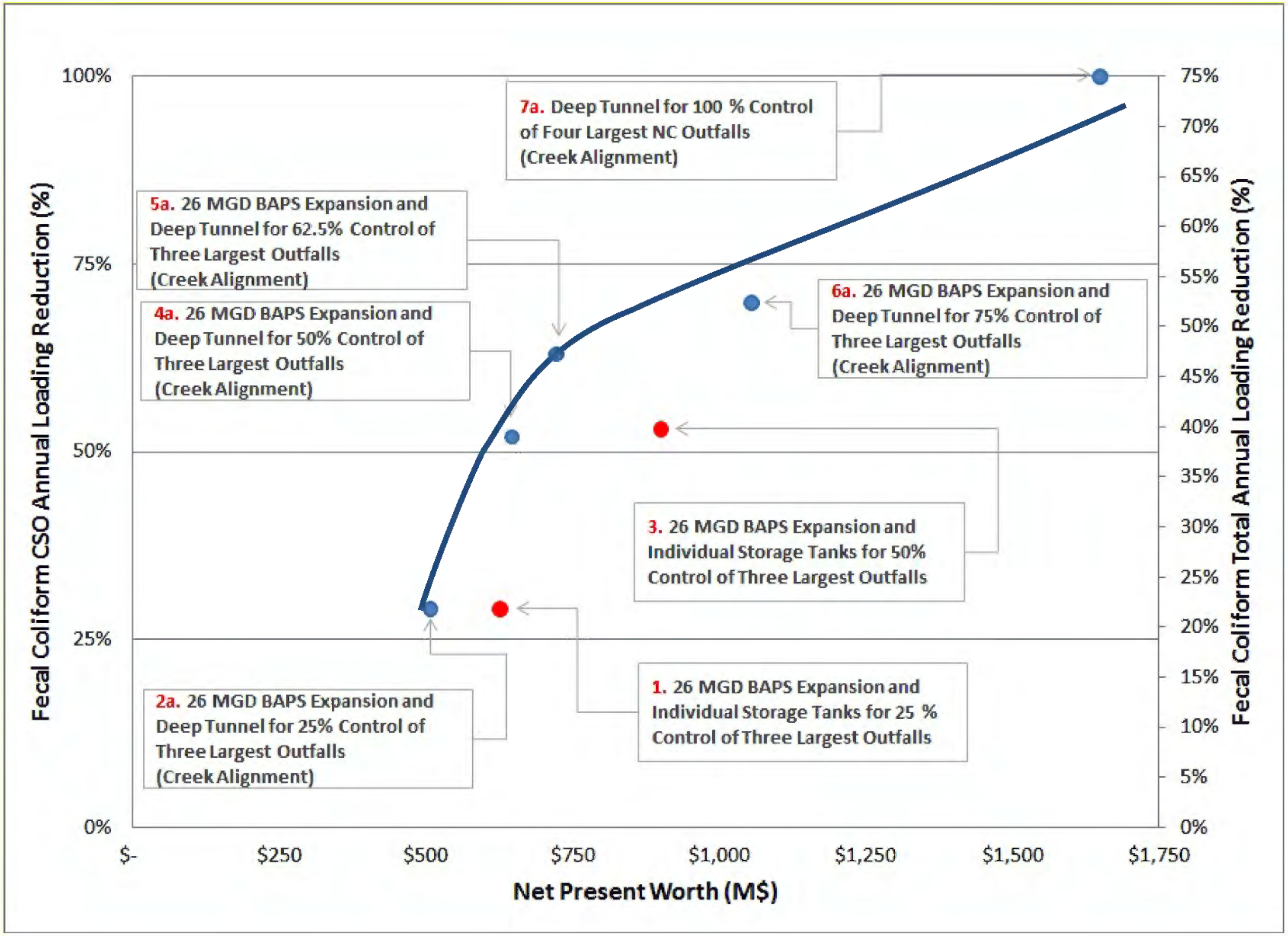

Figure 8-28. Cost vs. Fecal Coliform Loading Reduction (2008 Rainfall)

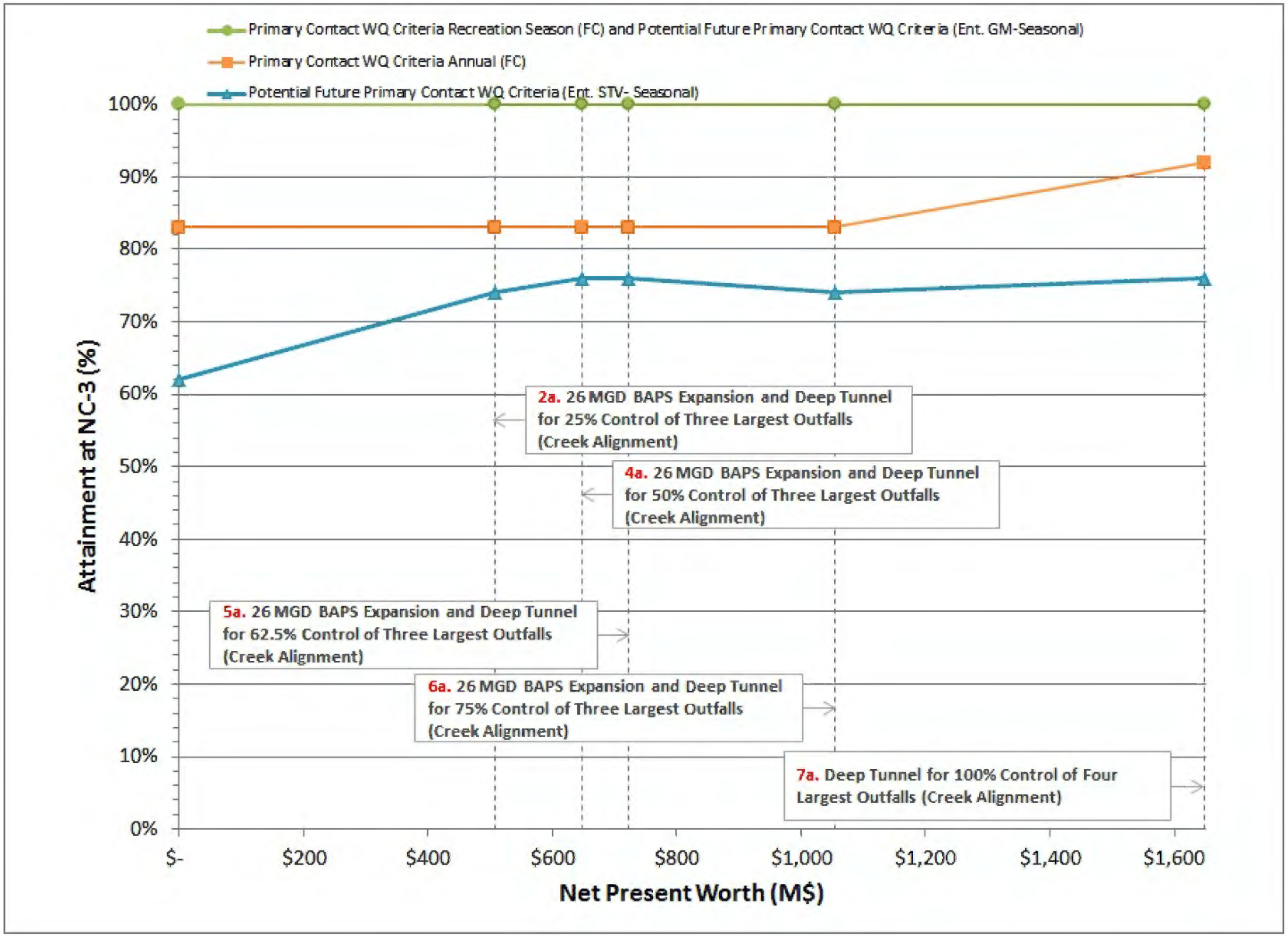

Figure 8-29. Cost vs. Bacteria Attainment at Station NC3 (2008 Rainfall)

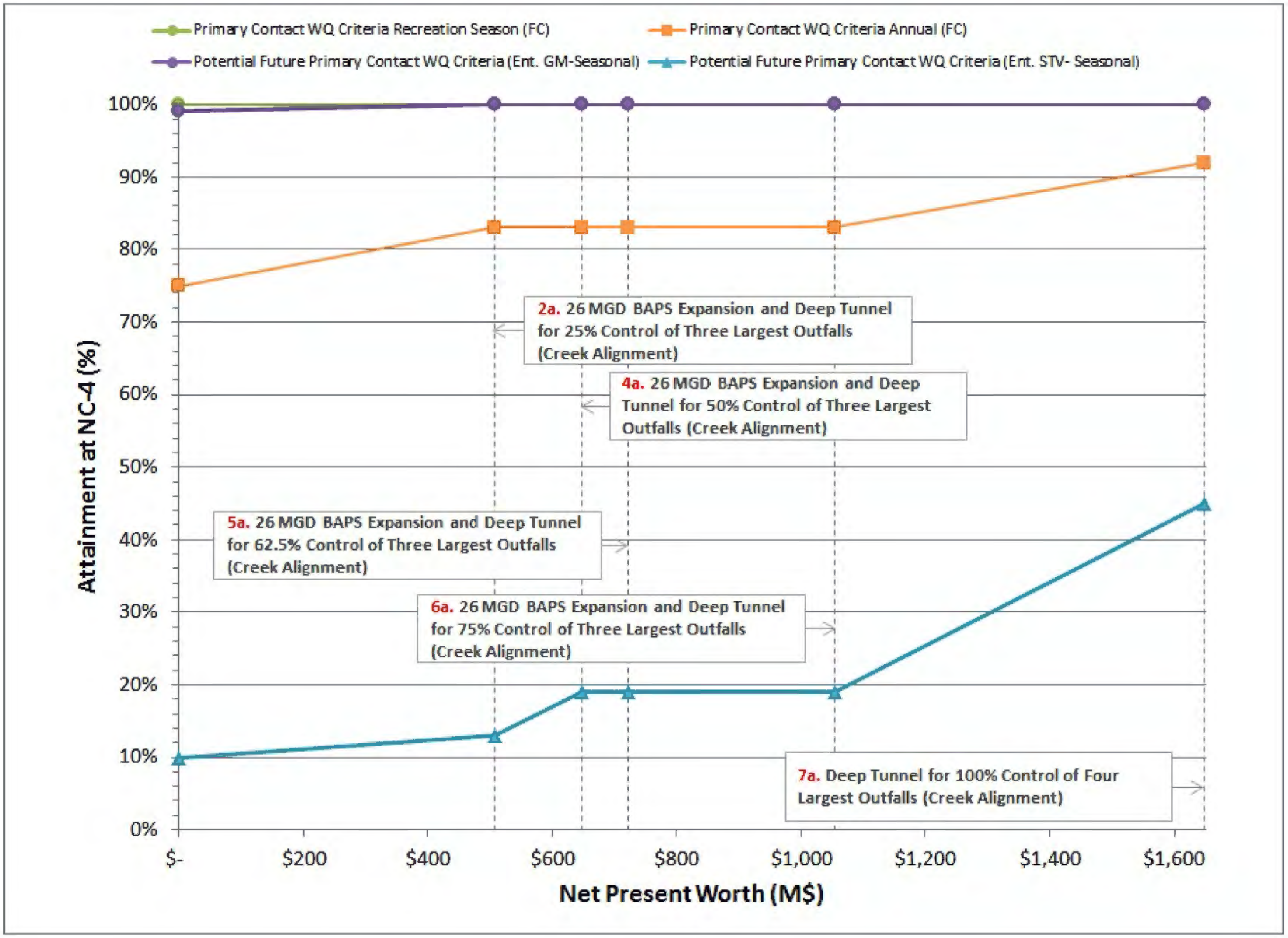

Figure 8-30. Cost vs. Bacteria Attainment at Station NC4 (2008 Rainfall)

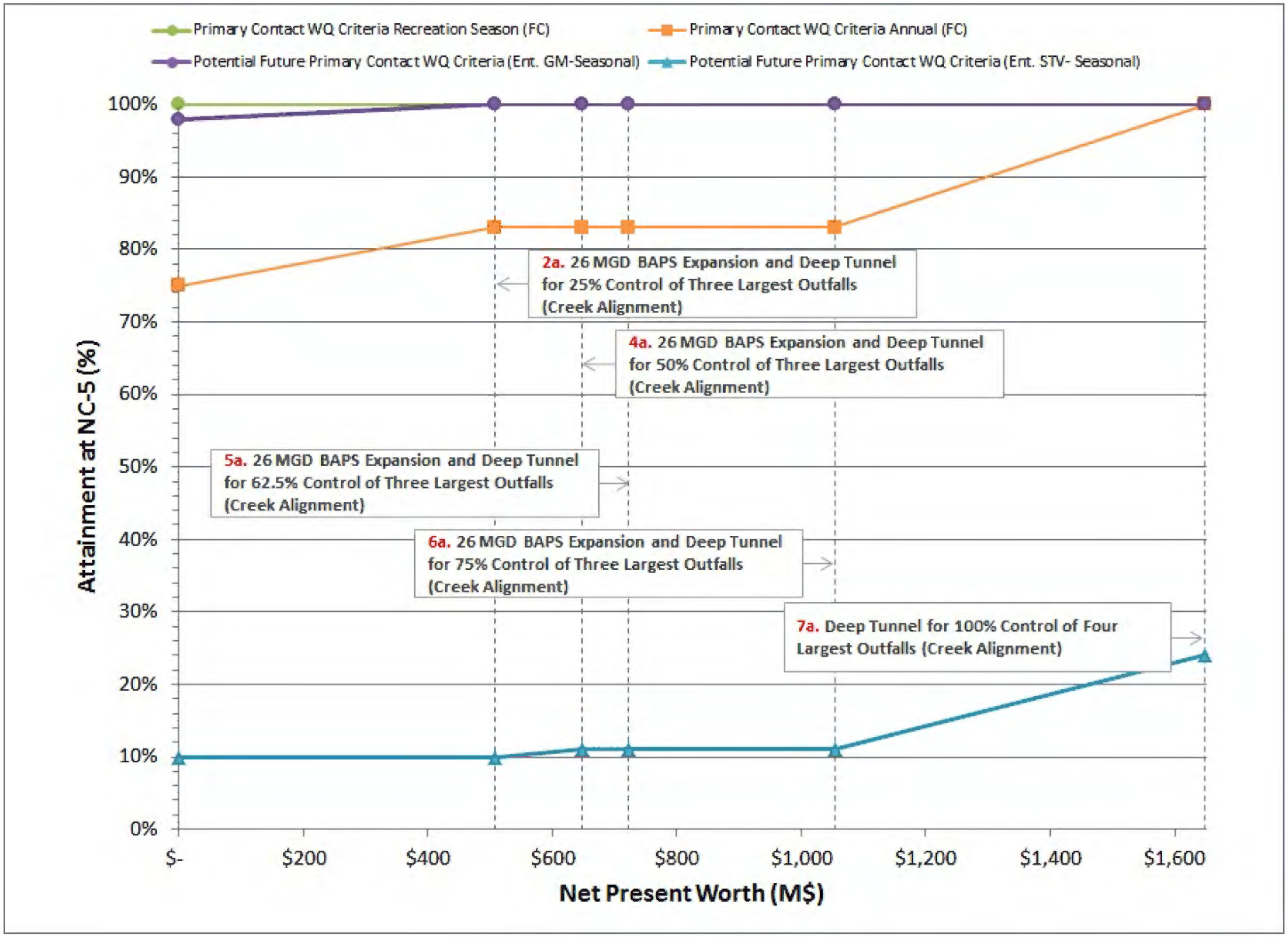

Figure 8-31. Cost vs. Bacteria Attainment at Station NC5 (2008 Rainfall)

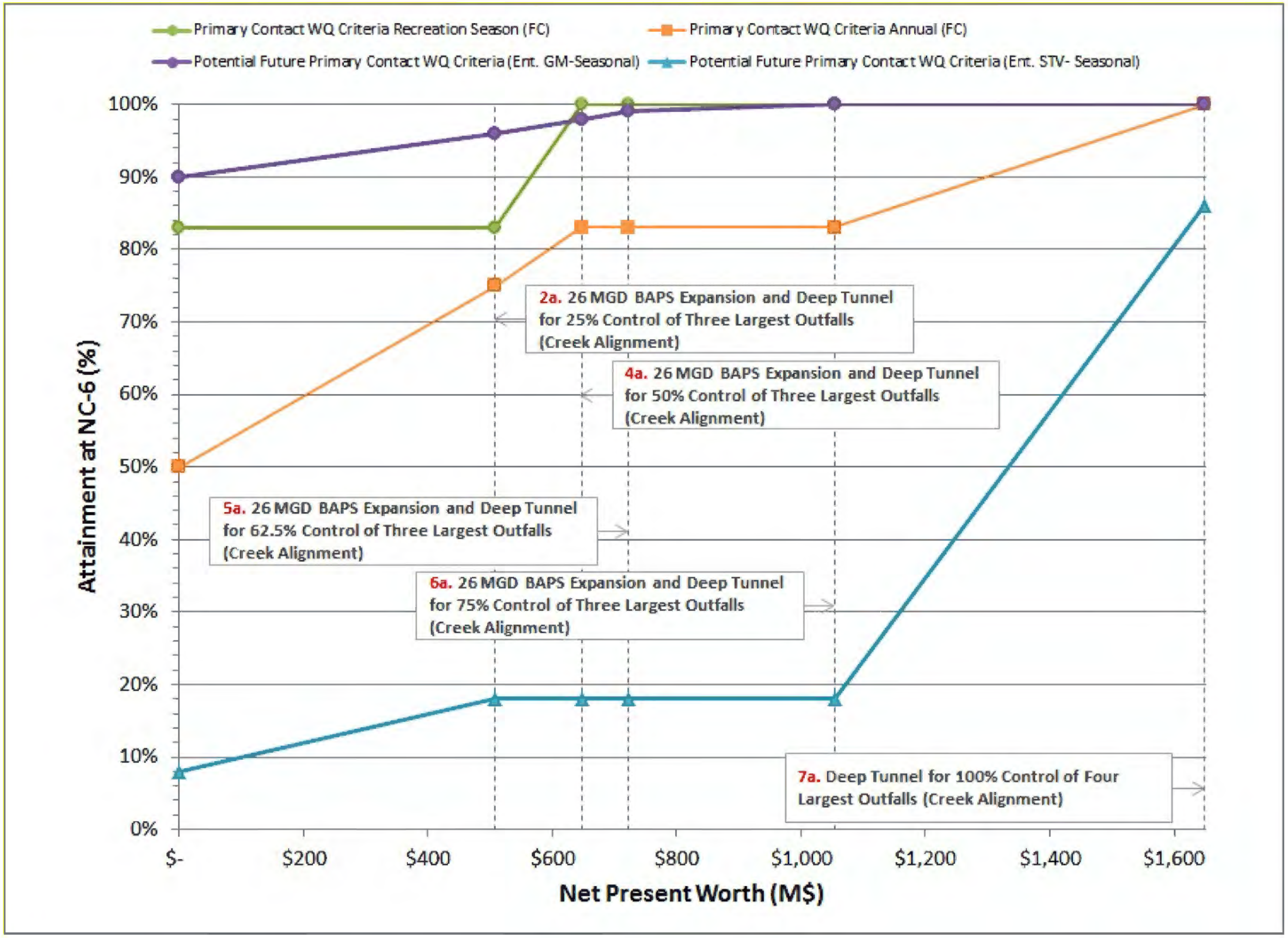

Figure 8-32. Cost vs. Bacteria Attainment at Station NC6 (2008 Rainfall)

AECOM with Hazen

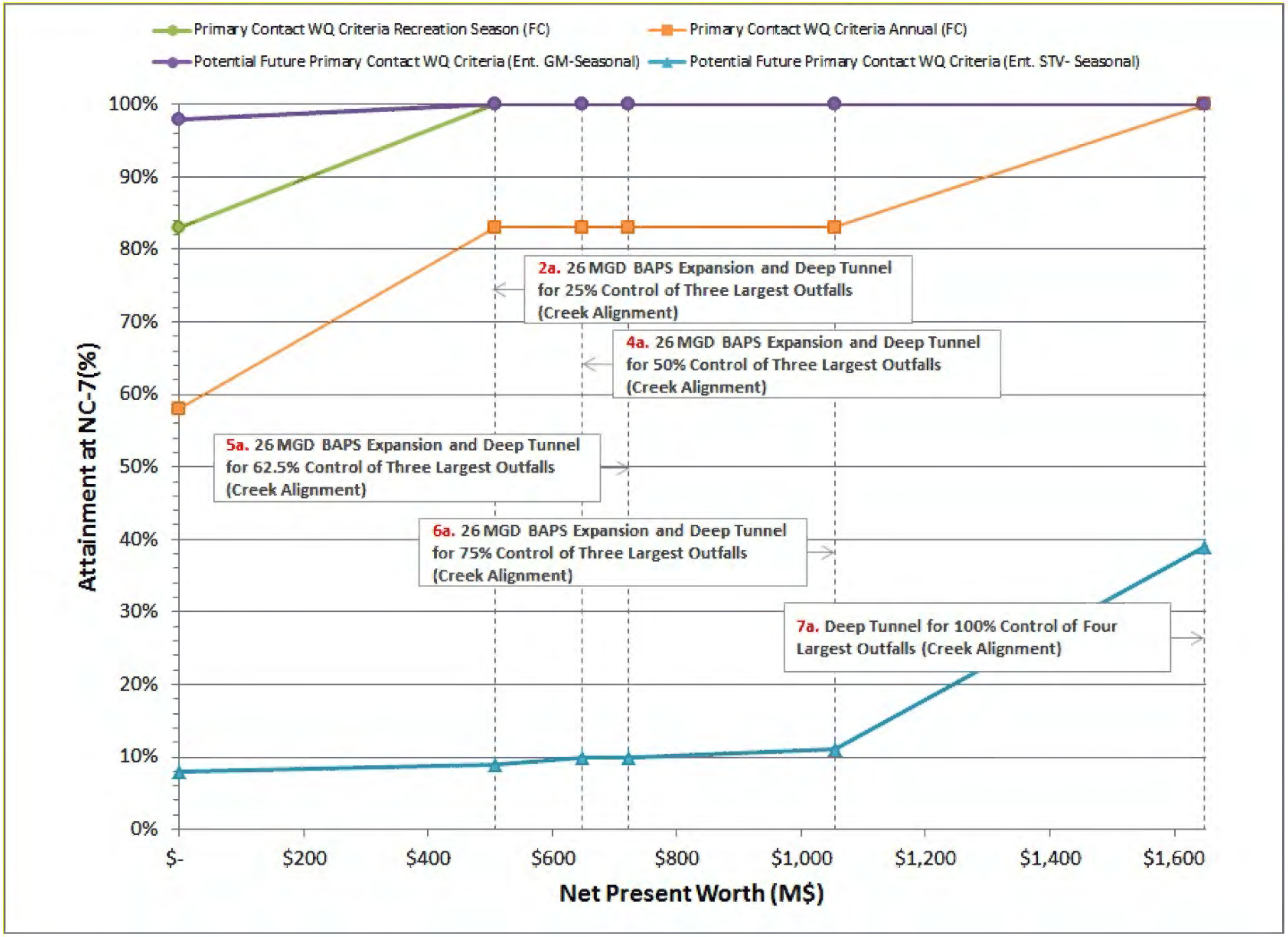

Figure 8-33. Cost vs. Bacteria Attainment at Station NC7 (2008 Rainfall)

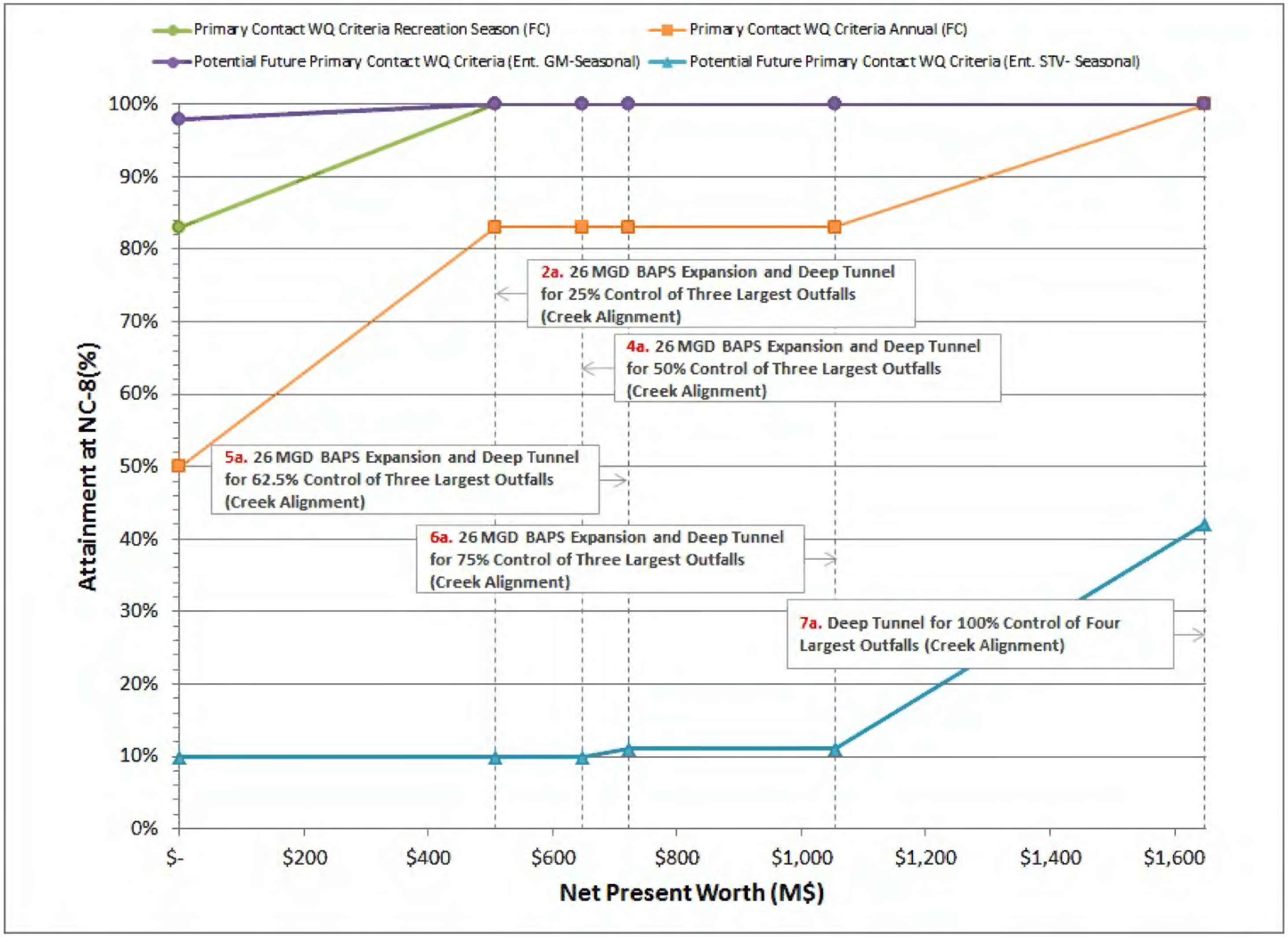

Figure 8-34. Cost vs. Bacteria Attainment at Station NC8 (2008 Rainfall)

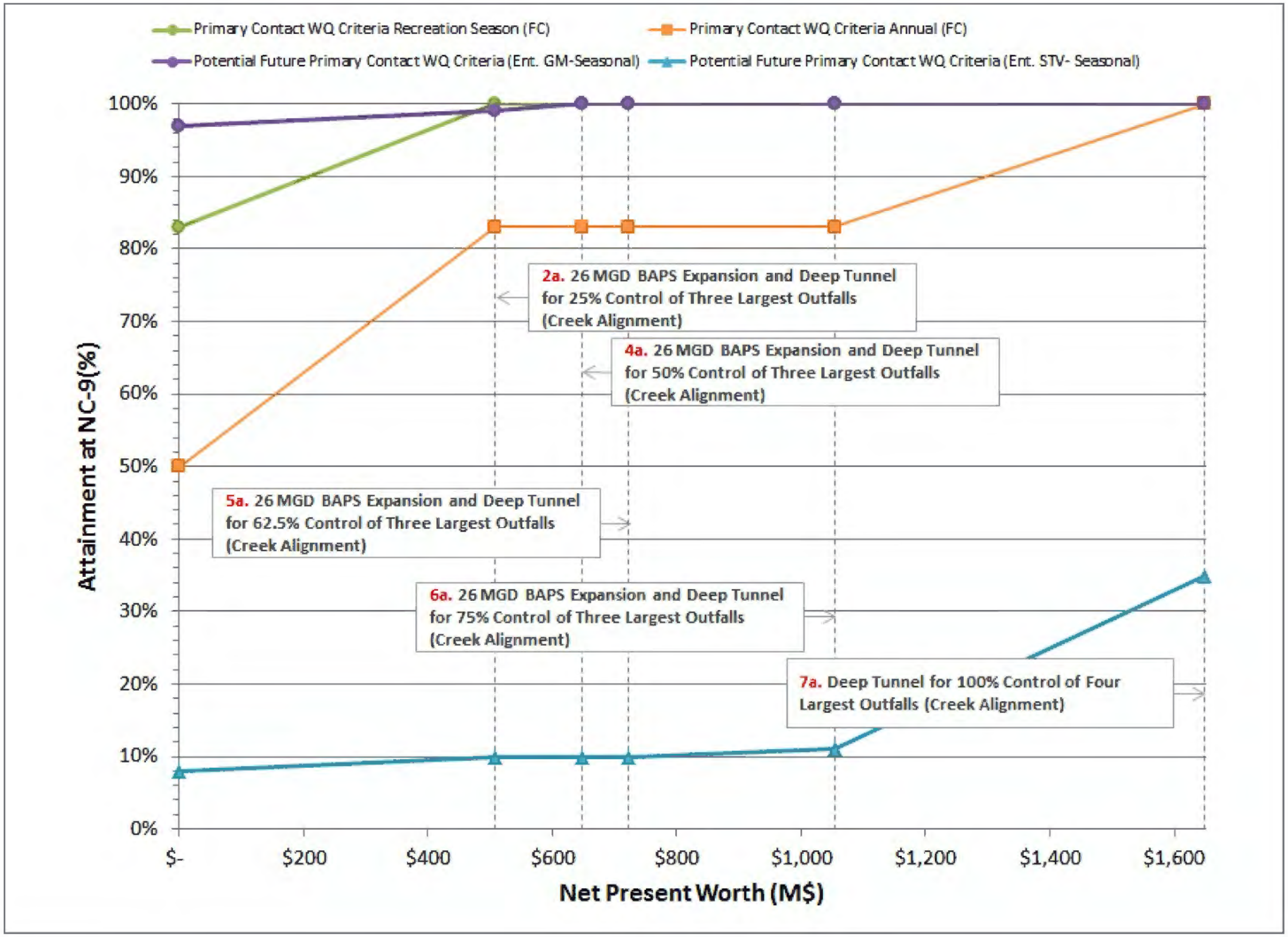

Figure 8-35. Cost vs. Bacteria Attainment at Station NC9 (2008 Rainfall)

AECOM with Hazen

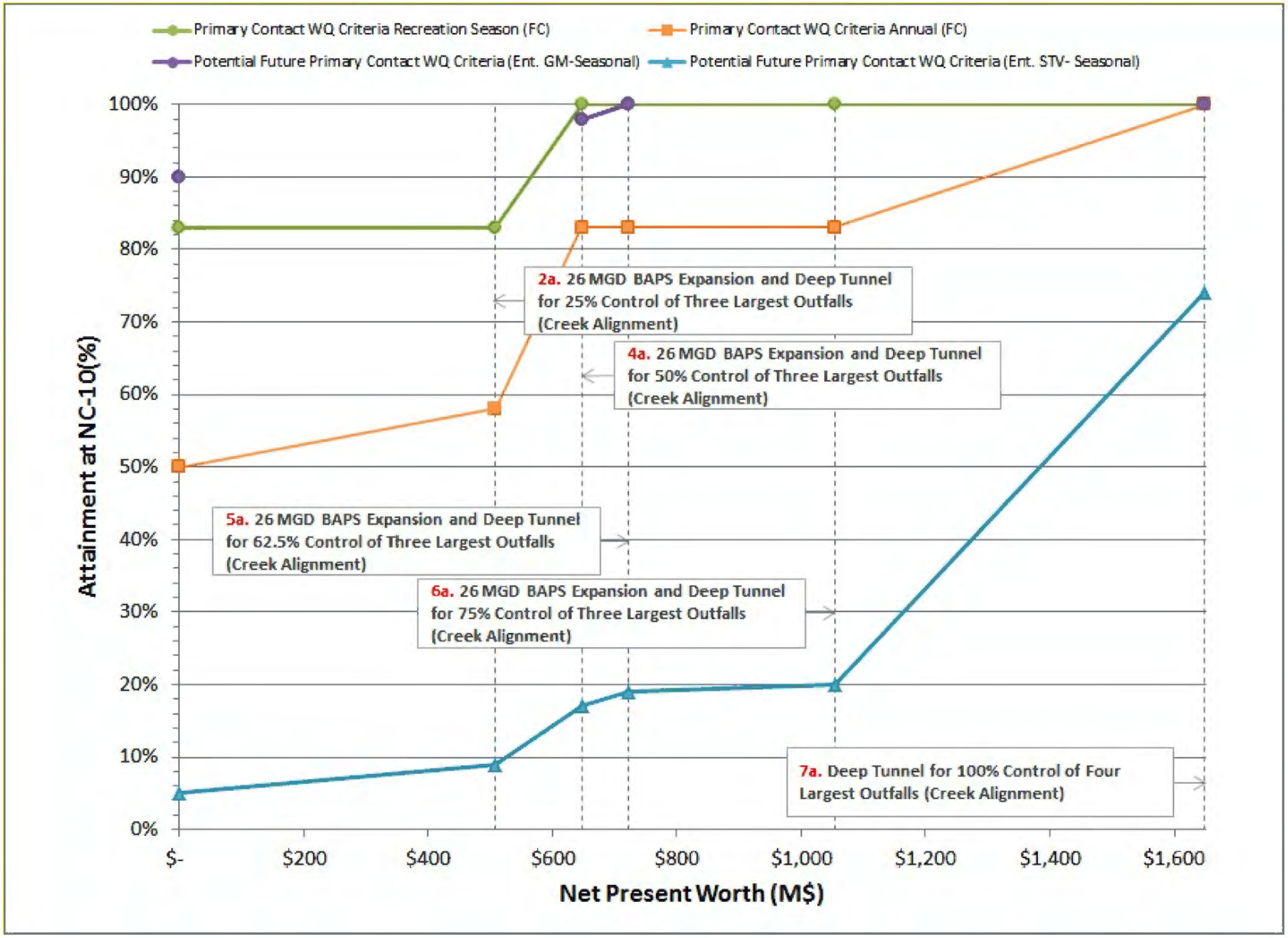

Figure 8-36. Cost vs. Bacteria Attainment at Station NC10 (2008 Rainfall)

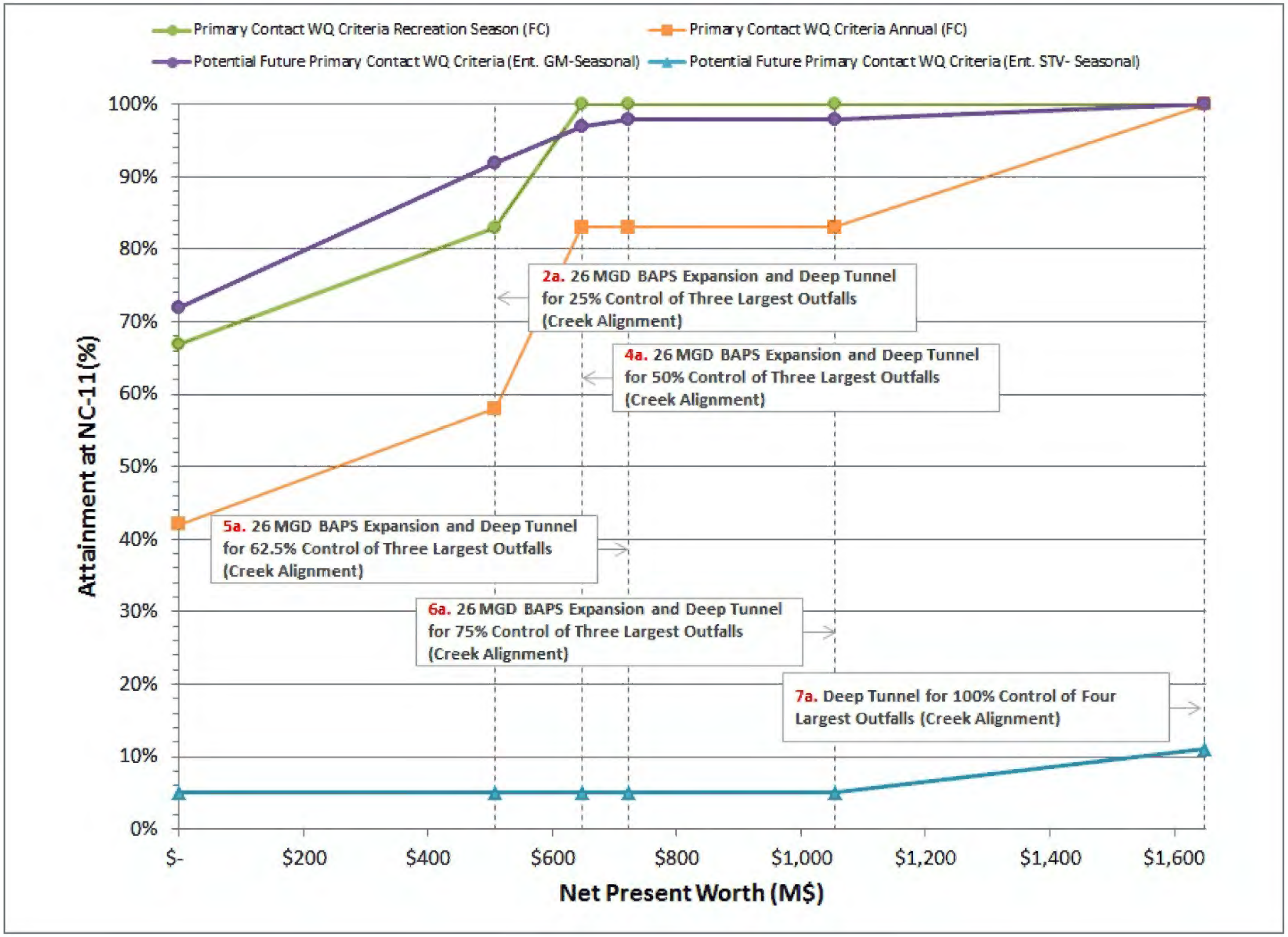

Figure 8-37. Cost vs. Bacteria Attainment at Station NC11 (2008 Rainfall)

AECOM with Hazen

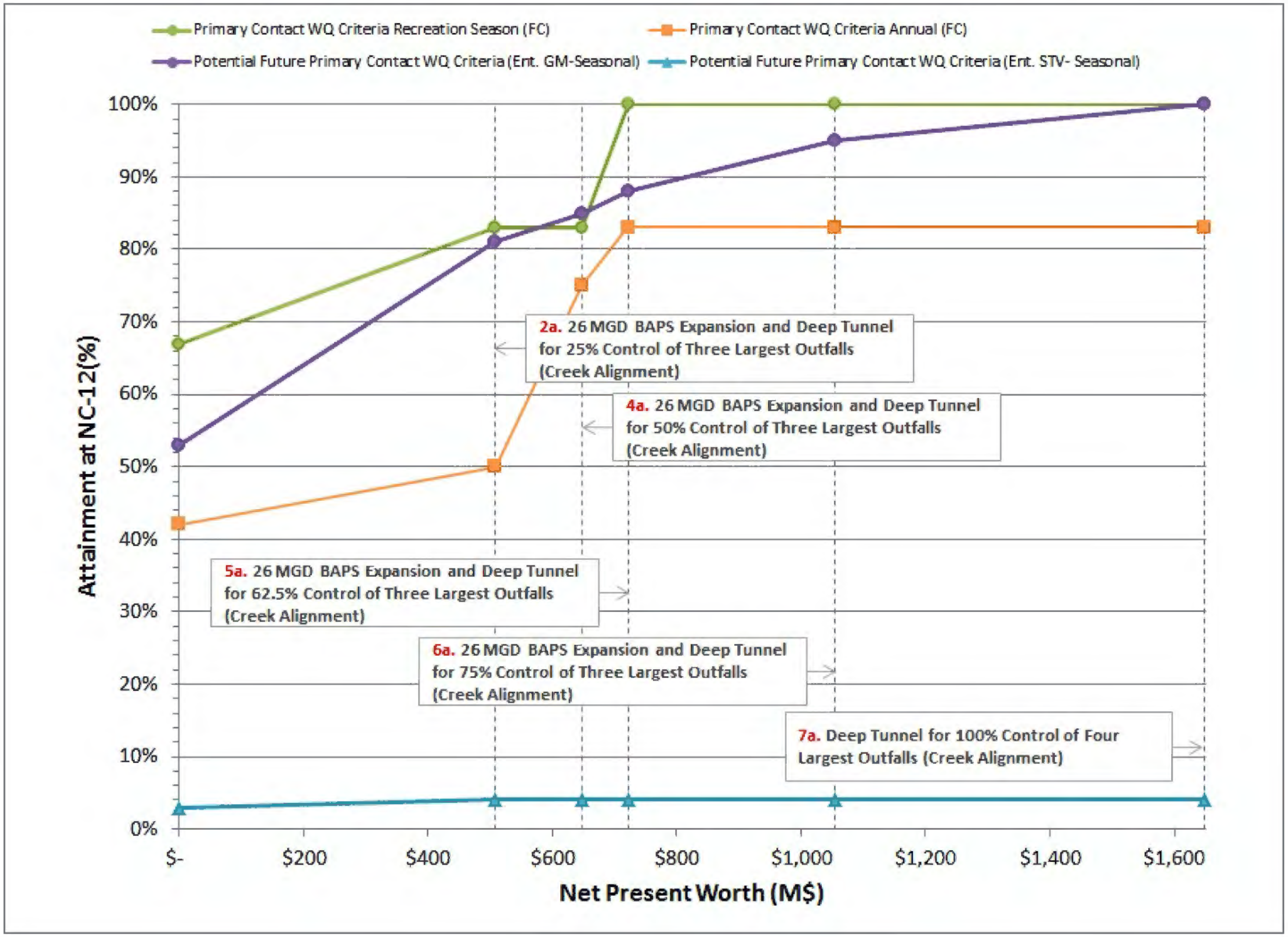

Figure 8-38. Cost vs. Bacteria Attainment at Station NC12 (2008 Rainfall)

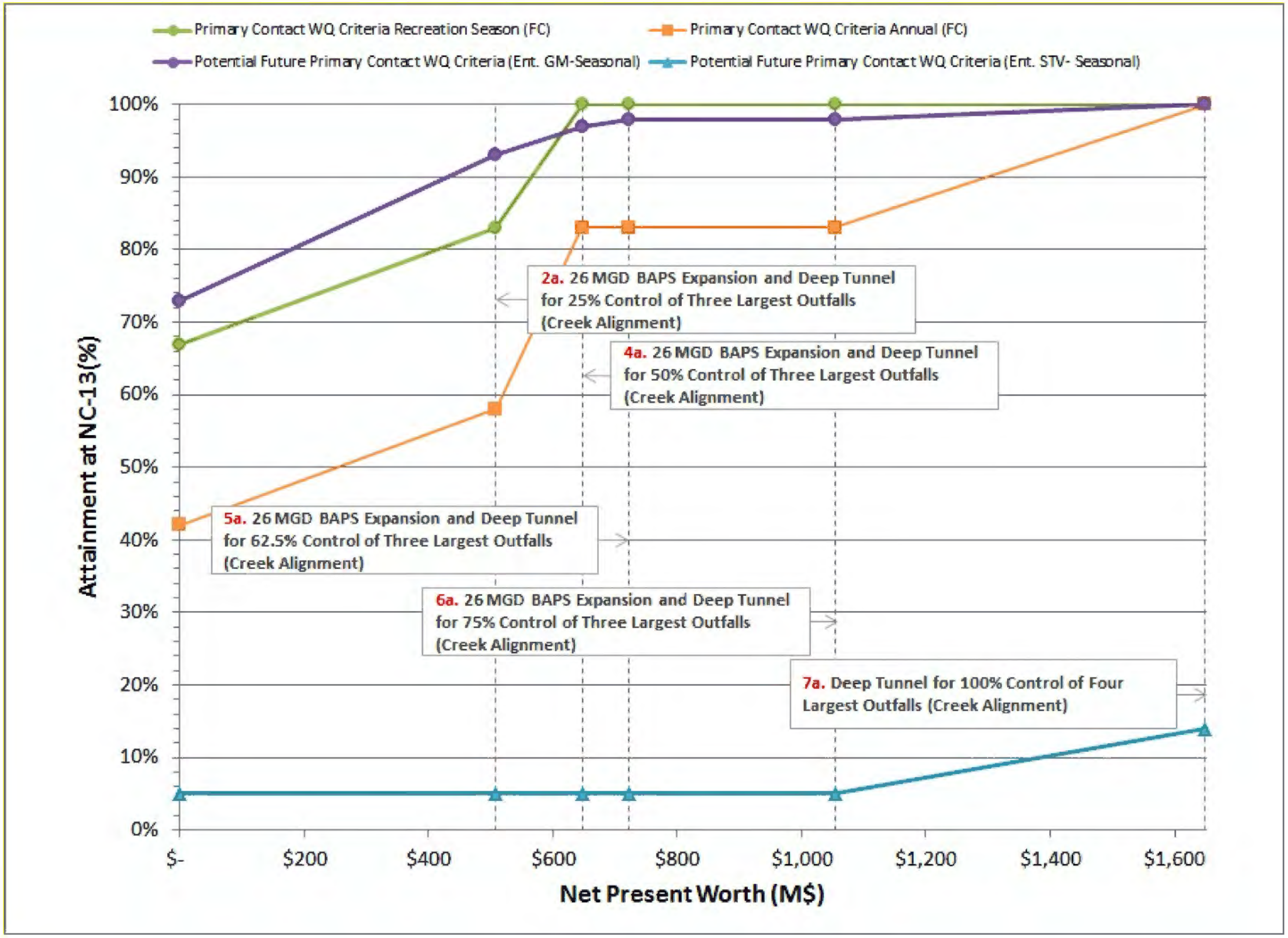

Figure 8-39. Cost vs. Bacteria Attainment at Station NC13 (2008 Rainfall)

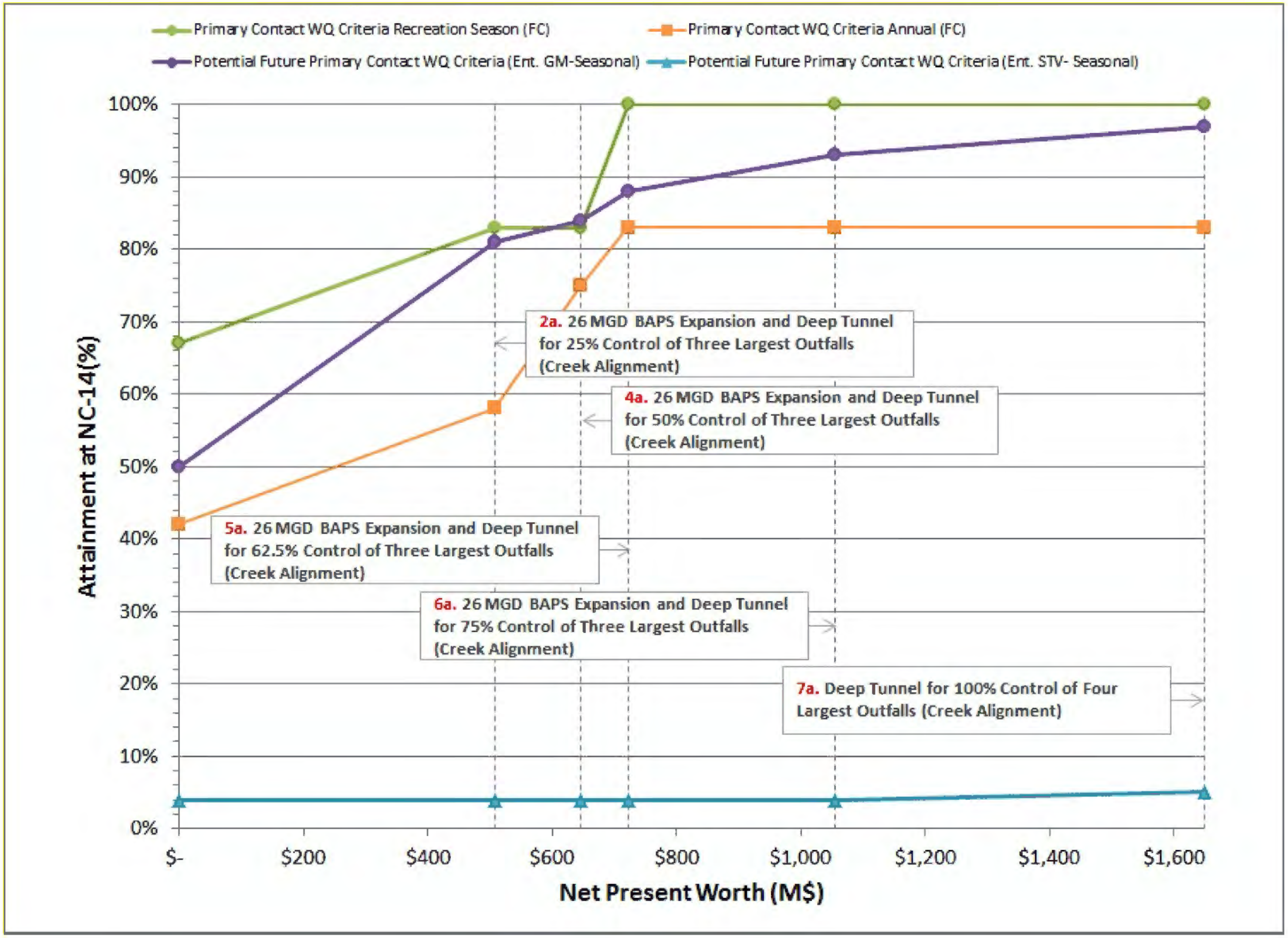

Figure 8-40. Cost vs. Bacteria Attainment at Station NC14 (2008 Rainfall)

8.5.c Conclusion on Preferred Alternative

The alternatives were reviewed for cost effectiveness, ability to meet water quality criteria, public comments and operations. The construction costs were developed as Probable Bid Costs (PBC), and the total Net Present Worth (NPW) costs were determined by adding the estimated PBC to the NPW of the projected annual O&M costs at an assumed interest rate of 3 percent over a 20-year life cycle. However, for tunnel alternatives that provide longer service, a longer 100-year lifecycle was used for computing NPW. Design, construction management and land acquisition costs are not included in the cost estimates. All costs are in February 2017 dollars and are considered Level 5 cost estimates by Association for the Advancement of Cost Engineering (AACE) International with an accuracy of -50 to +100 percent.

The selection of the preferred alternative is based on multiple considerations including public input, environmental and water quality benefits, and costs. A traditional KOTC analysis is presented above. As described above, based on that analysis, a 26 MGD expansion to the BAPS was identified as the most cost-effective alternative for reducing the frequency and volume of CSOs from Outfall BB-026 to Dutch Kills. For Outfalls NC-015, NC-083, and NC-077, the evaluations indicated that a storage tunnel would be more cost-effective and would have less siting impacts on established businesses than individual storage tanks. However, the final tunnel route depends on whether DEP is successful in obtaining a site near the Newtown Creek WWTP and/or resolving the potential competing uses for the DEP-owned site near Outfall NC-077. Based on the cost/performance curves presented above, a tunnel sized for 62.5 percent control fell on the KOTC for cost versus CSO volume and bacteria load controlled. A tunnel sized for 62.5 percent control is projected to achieve recreational season (May 1st through October 31st) attainment of the Existing WQ Criteria for bacteria at all sampling locations in Newtown Creek for the 2008 typical year. Assessment of compliance using a 10-year continuous model run indicated that recreational season compliance would be in the 83 to 93 percent range for the 62.5 percent control tunnel. Most of the main trunk of Newtown Creek and Dutch Kills is projected to be at 93 percent attainment, while the upstream reaches would be in the 83 to 90 percent range.

In comparison, a tunnel sized for 75 percent control fell beyond the KOTC for cost versus CSO volume and bacteria load controlled, meaning that the additional control achieved required a proportionally larger incremental cost compared to the 62.5 percent control tunnel. In terms of attainment, the 75 percent control tunnel would provide no improvement for the 2008 recreational season, as the 62.5 percent tunnel would already provide 100 percent attainment. For the 10-year continuous simulation, the recreational season attainment for the 75 percent tunnel would range from 90 to 95 percent, with only station NC4 achieving the 95 percent level. All other stations in the Creek would range from 90 to 93 percent. The 75 percent tunnel would therefore not achieve full attainment in the recreational season, and would provide only marginal improvement in attainment as compared to the 62.5 percent tunnel. As described above, the Newtown Creek WWTP is a high-rate, step-feed plant with no primary settling tanks. As such, a 40-MGD tunnel dewatering rate was determined to be an appropriate dewatering rate limit for the WWTP. This limitation would not constrain the dewatering rate for the 62.5 percent tunnel, but would require additional treatment capacity in the form of a retention treatment basin (RTB) to allow dewatering of the 75-percent tunnel within 24 hours. This requirement would complicate the implementation of a 75-percent tunnel due to the potential need for additional property acquisition, siting, construction, and long-term O&M requirements. This requirement also adds to the implementation cost for the 75-percent tunnel alternative.

In summary, the 62.5 percent tunnel provides the following:

1. 100 percent attainment of the Existing WQ Criteria for bacteria during the 2008 recreational season
2. The most cost-effective alternative, based on the KOTC analysis approach, consistent with EPA's CSO Control Policy
3. Is projected to have a time to recovery of less than 24 hours for 90% of the wet weather events.
4. Tunnel dewatering in 24 hours without the cost, siting, O&M, and other implementation issues associated with providing additional treatment for dewatering flows that would otherwise exceed the established limit for the Newtown Creek WWTP

Although the 62.5 percent tunnel would not achieve recreational season compliance with the Existing WQ Criteria for bacteria based on the 10-year continuous simulation, the 75-percent tunnel would provide only an incremental improvement, and still would not achieve full compliance. Nevertheless, the final siting of the dewatering pumping station, the tunnel alignment and other associated details of the tunnel alternative, will be evaluated further based upon a number of factors including additional modeling and will be finalized during subsequent planning and design stages. That additional planning will provide an opportunity to optimize the sizing of the tunnel. However, the ability of the Newtown Creek WWTP to handle the dewatering flows would remain a limiting factor for the sizing of the tunnel. Based on these considerations, the 62.5-percent tunnel has been selected as the preferred alternative for controlling CSO to Newtown Creek from outfalls NC-015, NC-083 and NC-077. Conceptual layouts for the tunnel alternatives are provided in Section 8.

Tables 8-27a and 8-27b below present the baseline and recommended plan annual overflow volumes and frequencies for 2008, for the Newtown Creek and East River CSOs associated with the Bowery Bay and Newtown Creek WWTPs.

Table 8-27a. 2008 Baseline and Recommended Plan CSO Volume and Overflows per Year – Newtown Creek CSOs

Waterbody/WWTP System	CSO	2008 Baseline		Recommended Plan	
		Volume	Annual Overflow Events	Volume	Annual Overflow Events
		Total Discharge (MG/yr)	Total (No./yr)	Total Discharge (MG/yr)	Total (No./yr)
Dutch Kills/BBL(1)	BB-004	0.1	1	0.0	0
	BB-009	43.0	34	28.3	24
Newtown Creek/BBL	BB-010	0.5	7	0.8	10
	BB-011	1.6	14	2.3	16
	BB-012	0.1	1	0.1	1
	BB-013	16.2	31	15.3	30
	BB-014	1.8	18	1.7	18
	BB-015	0.7	13	0.7	13

Table 8-27a. 2008 Baseline and Recommended Plan CSO Volume and Overflows per Year – Newtown Creek CSOs

Waterbody/WWTP System	CSO	2008 Baseline		Recommended Plan	
		Volume	Annual Overflow Events	Volume	Annual Overflow Events
		Total Discharge (MG/yr)	Total (No./yr)	Total Discharge (MG/yr)	Total (No./yr)
Dutch Kills/BBL	BB-026[3]	120	37	28.3	25
	BB-040	1.1	16	0.9	12
Newtown Creek/BBL	BB-042	1.5	22	1.2	17
	BB-043	9.4	32	8.6	33
English Kills/NCWWTP[2]	NCB-015[3]	321	31	119	13
Newtown Creek/NCWWTP	NCB-019	3.0	21	2.9	20
	NCB-021	0.0	0	0.0	0
	NCB-022	7.5	29	8.3	28
	NCB-023	0.5	8	0.6	9
	NCQ-029	18.7	40	17.8	37
Maspeth Creek/NCWWTP	NCQ-077[3]	300	41	100	18
Newtown Creek/NCWWTP	NCB-083[3]	314	42	112	22
	NCB-002[4]	N/A	N/A	N/A	N/A
Total		1,161	42 (max)	449	37 (max)

Notes:

(1) BBL = Bowery Bay Low Level Interceptor, to Bowery Bay WWTP
(2) NCWWTP = Newtown Creek WWTP system
(3) NCB-015 + NCB-083 + NCQ-077 + BB-026 = 91% of Total Annual Volume.
(4) NCB-002 is the Newtown Creek WWTP effluent outfall that discharges to Whale Creek Canal during peak flow and high tide conditions. This flow is treated before discharge.

Table 8-27b. 2008 Baseline and Recommended Plan CSO Volume and Overflows per Year – East River CSOs Associated with Newtown Creek WWTP and Bowery Bay WWTP Systems

Waterbody/WWTP System	CSO	2008 Baseline		Recommended Plan	
		Volume	Annual Overflow Events	Volume	Annual Overflow Events
		Total Discharge (MG/yr)	Total (No./yr)	Total Discharge (MG/yr)	Total (No./yr)
East River/BBL[1]	BB-016	1.8	17	1.7	16
	BB-017	1.7	20	1.6	20
	BB-018	1.1	17	1.1	16
	BB-021	23.4	34	22.5	34
	BB-022	1.0	12	1.0	11
	BB-023	16.4	30	16.1	28
	BB-024	36.4	28	35.9	28
	BB-025	11.0	30	10.9	29
	BB-027	6.1	27	6.1	27
	BB-028	352	44	349	43
	BB-029	105	32	105	32
	BB-030	27.6	43	27.5	43
	BB-031	3.9	18	3.9	18
	BB-032	1.9	17	1.9	17
	BB-033	6.1	28	6.1	29
	BB-034	202	57	202	57
	BB-035	3.9	32	3.9	32
	BB-036	8.9	30	8.9	29
	BB-037	0.6	8	0.6	8
Steinway Creek/BBL	BB-041	84.2	61	84.2	61
East River/BBL	BB-045	0.04	1	0.04	1
	BB-046	7.0	33	7.0	33
	BB-047	2.0	21	2.0	20
Subtotal BBL		**904**	**61 (max)**	**899**	**61 (max)**
East River/NCWWTP[2]	NC-003	0.4	10	0.4	10
	NC-004	15.9	36	17.0	36
	NC-006	92.2	42	104.5	42
	NC-007	7.5	31	8.0	31
	NC-008	21.6	32	24.4	31
	NC-010	0.0	0	0.0	1
	NC-012	30.8	15	36.7	18
	NC-013	58.3	28	72.9	27
Wallabout Channel/NCWWTP	NC-014	607	27	646.5	29
East River/NCWWTP	NC-024	0.0	0	0.0	0
	NC-025	0.5	10	0.5	11
	NC-026	0.3	7	0.3	10
	NC-027	13.3	31	16.1	30
	NC-082	0.6	10	0.6	10

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Table 8-27b. 2008 Baseline and Recommended Plan CSO Volume and Overflows per Year – East River CSOs Associated with Newtown Creek WWTP and Bowery Bay WWTP Systems

Waterbody/WWTP System	CSO	2008 Baseline		Recommended Plan	
		Volume	Annual Overflow Events	Volume	Annual Overflow Events
		Total Discharge (MG/yr)	Total (No./yr)	Total Discharge (MG/yr)	Total (No./yr)
Subtotal NCWWTP		848	42 (max)	929	42 (max)
Total		1,752	61 (max)	1,828	61 (max)

Notes:
(1) BBL = Bowery Bay Low Level Interceptor, to Bowery Bay WWTP
(2) NCWWTP = Newtown Creek WWTP system

This preferred alternative is projected to achieve recreational season (May 1st through October 31st) attainment of the Existing WQ Criteria for bacteria in Newtown Creek at all sampling locations in Newtown Creek for the 2008 typical year. The preferred alternative will also provide significant reduction in CSO volume and frequency of overflow. The implementation of the preferred alternative, which would include the storage tunnel for Outfalls NC-015, NC-083 and NC-077, plus the expansion of the BAPS to 26 MGD, has an estimated NPW ranging from $703M to $730M. This estimate reflects $5.0M of annual O&M over the course of 20 years, and an unescalated PBC ranging from $570M to $597M, depending on the final route to be determined in subsequent planning and design stages. Costs escalated to the assumed midpoint of construction would range from $1,275M to $1,335M. Note that these costs do not include costs for land acquisition, design and construction management.

The Existing WQ Criteria for fecal coliform attainment levels (monthly GM<200 cfu/100mL) as determined using the 10-year simulation are shown below in Table 8-28. As noted above, the values presented in Table 8-28 for the preferred alternative were interpolated from the 50 percent and 75 percent control runs. As indicated in Table 8-28, recreational season (May 1st through October 31st) compliance for the preferred alternative would be in the 83 to 93 percent range. Most of the main trunk of Newtown Creek and Dutch Kills would be at 93 percent attainment, while the upstream reaches would be in the 83 to 92 percent range. Annual compliance is predicted to be slightly lower than recreational season compliance. To put the 10-year simulation performance into perspective, the 10-year period includes a total of 60 months that fall within the recreational season. 93 percent attainment in the recreational season over 10 years means that in 56 out of the 60 recreational season months, the monthly GM did not exceed 200 cfu/100mL.

Table 8-28. Model Calculated Preferred Alternative Fecal Coliform Percent Attainment of Existing WQ Criteria and Bacteria Primary Contact WQ Criteria

Station		75% Control at BB-026, 62.5% Control at NC-015, 083, 077			
		2008 % Attainment		10 Year % Attainment(1)	
		Annual Monthly GM <200 cfu/100mL	Recreational Season(2) Monthly GM <200 cfu/100mL	Annual Monthly GM <200 cfu/100mL	Recreational Season(2) Monthly GM <200 cfu/100mL
Main Channel	NC4	83	100	90	93
	NC5	83	100	90	93
Dutch Kills	NC6	83	100	88	93
Main Channel	NC7	83	100	90	93
	NC8	83	100	90	93
	NC9	83	100	90	93
Maspeth Creek	NC10	83	100	89	92
English Kills	NC11	83	100	89	92
East Branch	NC12	83	100	83	88
English Kills	NC13	83	100	89	92
	NC14	83	100	83	83

Notes:

(1) Values interpolated from 10-year simulations of 50% and 75% control tunnel (with 75% control at BB-026) runs.

(2) The recreational season is from May 1st through October 31st.

The average annual attainment of the Existing WQ Criterion for DO (Class SD) for the entire water column is presented for the preferred alternative in Table 8-29. As indicated in Table 8-29, the Existing WQ Criterion for DO (Class SD) are predicted to be attained at all stations for the preferred alternative. The average annual attainment of the Class SC criteria for the entire water column is presented for the preferred alternative in Table 8-30. As discussed in Section 6, analysis of attainment of Class SC DO criteria are complex because the standard allows for excursions from the daily average limit of 4.8 mg/L for a limited number of consecutive calendar days. To simplify the analysis, attainment was based solely upon attainment of the daily average without the allowed excursions. The results indicate full attainment (at least 95 percent) of the acute criterion (never less than 3.0 mg/L) for the preferred alternative. Attainment of the chronic criterion (greater than or equal to 4.8 mg/L) ranges from 84 to 96 percent for the preferred alternative. As discussed in Section 6, the gap analysis indicates that with 100 percent CSO

Table 8-28. Model Calculated (2008) Preferred Alternative DO Attainment – Existing WQ Criterion – Aeration System Operational

Station		DO Annual Attainment (%) Class SD ≥ 3.0 mg/L 75% Control at BB-026, 62.5% Control at NC-015, NC-083, NC-077
Main Channel	NC4	100
	NC5	100
Dutch Kills	NC6	99.0
Main Channel	NC7	100
	NC8	100
	NC9	100
Maspeth Creek	NC10	99.7
English Kills	NC11	100
East Branch	NC12	100
English Kills	NC13	99.8
	NC14	96.2